VOL. 35, PART 4 DECEMBER 1952

The British Mycological Society

(Recognosce notum, ignotum inspice)

TRANSACTIONS

Edited by
P. H. GREGORY and G. C. AINSWORTH

CAMBRIDGE UNIVERSITY PRESS
LONDON: BENTLEY HOUSE, N.W.1
NEW YORK: 32 EAST 57TH STREET, 22

OFFICERS AND COUNCIL FOR 1952

President

A. A. PEARSON, F.L.S.

Vice-Presidents

W. C. MOORE, M.A.
G. C. AINSWORTH, B.Sc., Ph.D., F.L.S.
P. H. GREGORY, D.Sc., F.L.S.

Secretary

C. J. HICKMAN, B.Sc., M.Sc., Ph.D.
Department of Botany, The University, Edgbaston, Birmingham, 15

Foray Secretary

G. SMITH, M.Sc., F.R.I.C.
London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C. 1

Treasurer

W. BUDDIN, M.A.
Chiltern Court, St Peter's Avenue, Caversham, Reading, Berks.

Editors

P. H. GREGORY, D.Sc., F.L.S.
Rothamsted Experimental Station,
Harpenden, Herts.

G. C. AINSWORTH, B.Sc., Ph.D., F.L.S.
University College,
Exeter, Devon

Council

The OFFICERS with the following in addition:

J. BROOKE
Miss F. JOAN MOORE
I. F. STOREY
M. B. ELLIS
P. D. ORTON
Mrs M. P. TOPPING
F. B. HORA
N. F. ROBERTSON
J. WEBSTER

B. BARNES, Prof. W. BROWN, A. D. COTTON, Prof. Dame HELEN GWYNNE-VAUGHAN, J. RAMSBOTTOM, E. W. SWANTON, Miss E. M. WAKEFIELD, M. WILSON.

PLANT PATHOLOGY COMMITTEE

Chairman

S. D. GARRETT, M.A., Sc.D., D.I.C.

Secretary

C. C. V. BATTS, B.Sc., Ph.D.
National Institute of Agricultural Botany, Huntingdon Road, Cambridge

J. COLHOUN
Miss L. E. HAWKER
E. C. LARGE
P. H. WILLIAMS
S. H. CROWDY
S. J. HUGHES
E. LESTER
W. J. DOWSON
P. H. GREGORY
Miss M. NOBLE

THE PRESIDENT and the SECRETARY *ex officio*

Recorder

(new British species and records)
M. B. ELLIS, B.Sc., Ph.D.
Commonwealth Mycological Institute, Ferry Lane, Kew, Surrey

The subscription price is 50*s.* per volume (post free), or $8.50 in U.S.A., payable in advance. Subscriptions may be sent to any Bookseller, or to the Cambridge University Press, Bentley House, 200 Euston Road, London, N.W. 1.

Enquiries from the U.S.A. should be addressed to the Cambridge University Press, American Branch, 32 East 57th Street, New York 22.

Medical Mycology

An Introduction to its Problems

By G. C. Ainsworth, B.Sc., Ph.D., F.L.S.; Department of Botany, University College of the South-West of England, Exeter, Devon. A sound introduction to the subject, with extensive references to the available published material. It can usefully be studied by all students of mycology, medicine and microbiology who are interested in the problems it deals with, while for those who intend to specialize in medical mycology it will prove invaluable. With 8 plates and other illustrations. 15*s.* net

From booksellers. Published by

PITMAN, *Parker Street, Kingsway, London, W.C.2*

Flora of the British Isles

A. R. CLAPHAM, T. G. TUTIN & E. F. WARBURG

376 *text-figures.* 50*s. net*

British Stem- and Leaf-Fungi

W. B. GROVE

Vol. I. Sphaeropsidales. 31 *text-figures.* 45*s. net*

Vol. II. Sphaeropsidales (*cont.*) and Melancolniales. 133 *text-figures.* 45*s. net*

The Structure and Development of the Fungi

H. C. I. GWYNNE-VAUGHAN & B. BARNES

Frontispiece. 309 *text-figures.* 30*s. net*

CAMBRIDGE UNIVERSITY PRESS
Bentley House, 200 Euston Road, London, N.W.1

Digitized by the Internet Archive
in 2024

https://archive.org/details/fungal-biology_1952-12_35_part-4

Vol. 35, Part 4 December 1952

ASPERGILLUS BREVIPES N.SP.

By GEORGE SMITH

London School of Hygiene and Tropical Medicine

(With Plate 10)

A description is given of a new species of *Aspergillus* isolated from Australian soil. It is characterized by the production of intensely pigmented mycelium, and of many sessile conidial heads.

Aspergillus brevipes sp.nov.

Coloniis in agaro Czapekii lente crescentibus, velutinis, albis dein flavo-virentibus; guttulis incoloratis; reverso atro-virente, brunneo, purpureoque. Coloniis in musto ex hordeo, aut decocto tuberorum, lente crescentibus, tenuis, corrugosis, flavo-virentibus et roseo-vinosis; reverso atro-purpureo, pigmento in agaro diffluente. Capitulis coniodioferis radiatis, rare subcolumnaribus; stipitibus brunneolis, sinuosis, interdum septatis, ad 100 μ × 3–4·5 μ, saepe absentibus (i.e. vesiculosis in hyphis repentibus sessilibus); vesiculosis pyriformibus, ad 18 μ × 14 μ, plerumque solum in parte superiore fertilibus; metulis absentibus; phialidibus numerosis, 4·8–6 μ × 3–3·2 μ: conidiis globosis, spinulosis, 3–3·2 μ diam.; hyphis cum pigmento purpureo intracellulare.
Habitat in solo. Australia.

Through the kindness of Dr J. M. Vincent, of the Department of Agricultural Microbiology, University of Sydney, and Prof. E. C. Hallsworth, at that time Senior Lecturer in the same Department, a number of samples of Australian soils were sent, in June 1950, to the Department of Biochemistry, London School of Hygiene and Tropical Medicine, for the purpose of isolating moulds of biochemical interest. The mould here described was isolated by Mrs S. Marcus of this Department from a gley podsol developed in association with Alpine humus in a hollow at about 6300 ft. in the Alpine tract of Kosciusko.

On the dilution plates the new *Aspergillus* was conspicuous because of its vinaceous pink colour and highly pigmented reverse. Microscopic examination showed heads with closely packed phialides and no metulae, suggestive of *A. fumigatus*. The most interesting feature of the mould, and the one which suggested the specific epithet, is the lack of stalks to many of the conidial heads, the vesicles being virtually sessile on trailing hyphae.

On malt or potato agar it grows somewhat slowly, producing first a vinaceous pink mycelium, and tardily developing dull yellowish green conidial areas, which are velvety, much convoluted, with reverse deep purple, the pigment diffusing only slightly. On Czapek agar it grows slowly to give a dull yellowish green, velvety, heaped and convoluted colony, with reverse at first dull yellow to dirty green, becoming slowly purple. On Czapek agar with 20% sucrose growth is very slow, thin, green, reverse not pigmented. On corn-meal agar it grows slowly, forming a thin green colony with bright pink reverse.

Vol. 35, *Part* 3: *issued* 26 *September* 1952.

Heads mostly irregularly radiate, rarely more or less columnar; stalks often entirely lacking, when present brownish, sinuous, occasionally with one septum, up to 100 μ long and 3–4·5 μ in diameter; vesicles more or less pear-shaped, brownish, fertile over the upper half or two-thirds, varying in size up to 18 × 14 μ; metulae absent; phialides closely packed, 4·8–6 × 3–3·2 μ; conidia globose, finely spinulose, 3–3·2 μ in diameter; vegetative hyphae (on beer wort or potato agar) containing intracellular purple pigment, which becomes bright rose pink in lacto-phenol but does not diffuse out.

The fungus is quite unlike any other species of *Aspergillus* hitherto described. The brownish, sinuous stalks (when present) suggest affinity with *A. nidulans* or *A. ustus*, but no perithecia are produced and no hülle cells, such as are freely produced by the latter two species, have been seen; also the heads have no metulae. The general appearance of the heads in fluid mounts suggests relationship with *A. fumigatus*, but in that species the stalks are colourless to slightly greenish, and the spore chains form long solid columns. The structure of the heads, the rough spores, and the slow rate of growth indicate that its affinity is probably with the *A. restrictus* series, in spite of the fact that the spore chains have little tendency to form columnar masses. A number of species of the genus tend to produce, on some media, reduced heads, with very short stalks, dwarf vesicles, and few phialides, but, so far as is known, *A. brevipes* is unique in forming normal-sized heads completely devoid of stalks.

A dried culture of *A. brevipes* grown on potato-dextrose agar at 24° C., which has been deposited in the Herbarium of the Royal Botanic Gardens, Kew, is designated as the type. Cultures are maintained at the L.S.H.T.M. and subcultures will be distributed to the Commonwealth Mycological Institute, Kew; the Centraalbureau voor Schimmelcultures, Baarn; and the Northern Regional Research Laboratory, Peoria, Illinois.

EXPLANATION OF PLATE 10

Aspergillus brevipes

Fig. 1. Stalked conidial heads. From slide culture on Czapek agar. × 1000.

Fig. 2. Sessile conidial heads. From culture on malt agar. × 1000.

(*Accepted for publication* 27 *November* 1951)

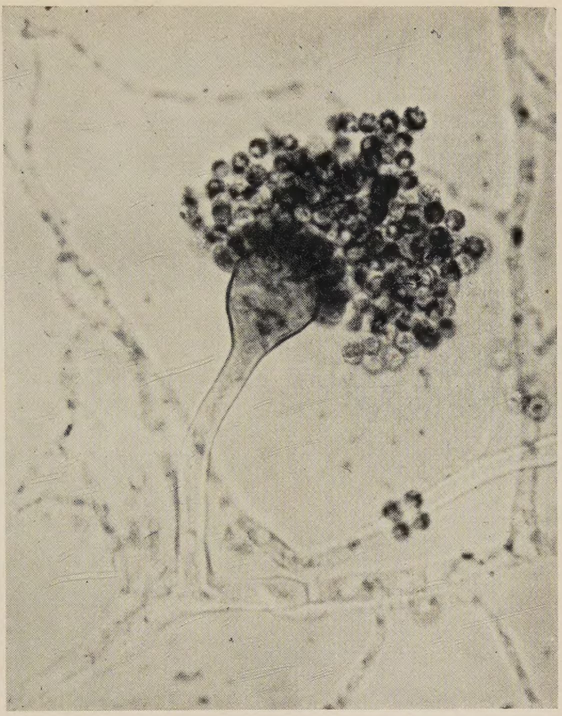


Fig. 1.

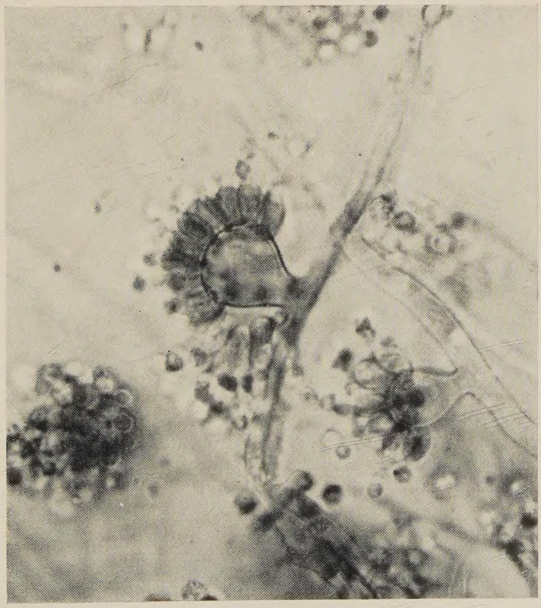


Fig. 2.

SPEIRA STIPITATA

By S. J. HUGHES

Commonwealth Mycological Institute, Kew, Surrey

(With 4 Text-figures)

Speira stipitata is illustrated, described and reclassified into *Ceratosporella.*

This fungus became known to me first from a preparation made by Mr E. W. Mason from a collection [on wood], preserved in Herb. Persoon in Herb. Lugd. Bat. (90.0.H. No. 910.261–925), labelled *Helminthosporium nanum* [Nees ex Fr.] by Persoon. Some conidia from this collection are illustrated in Fig. 1. *H. nanum* Nees is a *Dendryphion* and distinct from *Speira stipitata* Goidànich (1934).

In October 1951 Dr R. W. G. Dennis handed me a dead branch of *Carpinus betulus* collected by him at Watery Grove, Stevenage, Herts (part as Herb. I.M.I. 47161) which was almost covered by *Speira stipitata* in beautiful condition; it has not previously been recorded for Britain, and conidiophores and conidia from it are illustrated in Fig. 2. For reasons given later the following new combination is proposed.

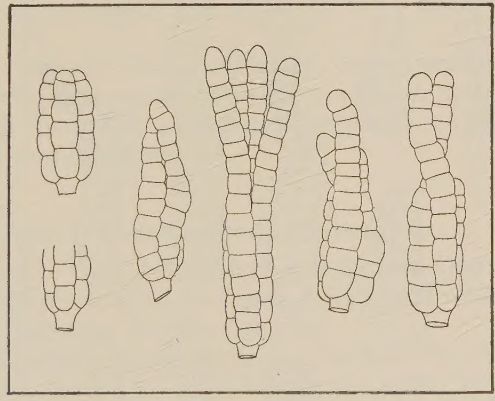


Fig. 1. *Ceratosporella stipitata*: conidia from collection in Herb. Persoon in Herb. Lugd. Bat.; × 500.

Ceratosporella stipitata (Goid.) Hughes comb.nov.

≡*Speira stipitata* Goidànich, *Malpighia*, **12**, 38, 1934.

Description of Ceratosporella stipitata

Colonies effuse, extensive, black, velutinous, occasionally tufted.

Mycelium immersed or semi-immersed, composed of subhyaline to brown, branched, septate hyphae 2–4 μ wide.

Conidiophores erect, simple, straight, seldom curved, smooth, very dark brown to almost black, thick-walled, closely septate (cells 6–8 μ long), arising solitarily or in groups of 2 to 3; they are up to 110 μ long, generally

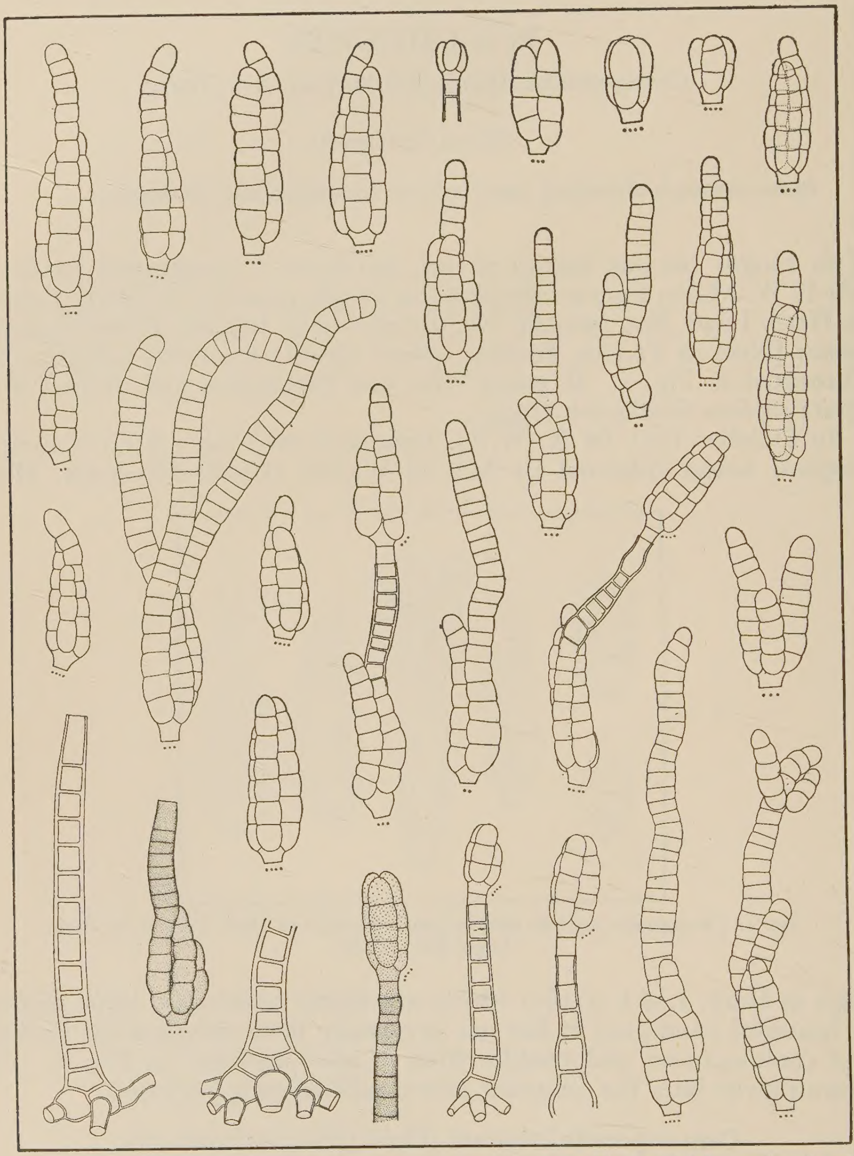


Fig. 2. *Ceratosporella stipitata*: conidiophores and conidia from Herb. I.M.I. 47161; the do accompanying each conidium indicates the number of arms in each particular conidiu × 500.

shorter, swollen at the base, then 7–10 μ and tapering subulately to th flattened apex which is 5–6 μ wide. They arise as erect lateral branches immersed or semi-immersed hyphae and further hyphae may then gro out from the basal cell; occasionally, some of the hyphal cells next to the conidiophore swell up considerably so that the base of the conidiophore is composed of a group of cells in the form of a very small stroma about 25 μ wide. Mature conidiophores show a series of barely perceptible circular ridges and slightly paler circular bands towards the apex due to the proliferation of the conidiophore through the scars left by fallen conidia.

Conidia develop singly and successively as the blown-out ends of conidiophores and of their successive apical proliferations. They are smooth and composed of a basal shortly clavate cell about 6 μ long with a truncate base bearing the flat scar which is 5–6 μ wide; this cell bears a lateral whorl of two to five (mostly three to four) arms which are nearly always erect and closely adpressed along their whole length; they are up to about 70 μ long, 11–18 μ wide, brown to dark brown but paler towards the apex. Individual arms are 7–9 μ wide towards the base, tapering somewhat towards the rounded apex, septate, constricted at the septa and with the cells 5–7 μ long. Such conidia are the usual type but a number of variations occur.

In some conidia one or more arms will elongate up to 130 μ, and although closely adpressed towards the base the proliferated arms are free and divergent towards the apex. The cells of such proliferated arms are shorter and the constrictions less apparent than in the cells towards the base.

Occasionally, one of the proliferated arms becomes modified into a conidiophore which is darker than the conidium, not constricted at the septa, and which is capable of bearing a series of conidia at the apex just like an ordinary conidiophore.

The systematic position of Ceratosporella stipitata

When Goidànich (1934) described and figured *Speira stipitata*, he gave an emended description of *Speira* Corda (1837) and included three species disposed in the following three subgenera:

A. *Euspeira* Lindau—*Speira toruloides* Corda. This subgenus was proposed by Lindau (1910, p. 197) for species with 'spore chains bound together in a single, flat layer'.

B. *Cattanea* (Garov.) Lindau—*Speira heptaspora* (Garov.) Sacc. The generic name *Cattanea* was proposed by Garovaglio (1875) for his single [type] species *C. heptaspora* which was illustrated and described on the wood of dead roots of *Citrus limonum* and *C. aurantium* in Italy. The conidia were described as borne generally in a group of seven on a very short conidiophore, at first adpressed and later divergent, cylindric-fusiform, 6- to 10-celled and 30 μ long; Garovaglio figured the germination of such an isolated conidium.

The name *Cattanea* was first used as a subgenus by Lindau (1910, p. 199) for species of *Speira* with 'spore chains bound together into a spore body of more than one layer'.

C. *Stipitata* Goid.—*Speira stipitata* Goid. This subgenus was published for species of *Speira* with conidia as in *Cattanea* but borne on long conidiophores.

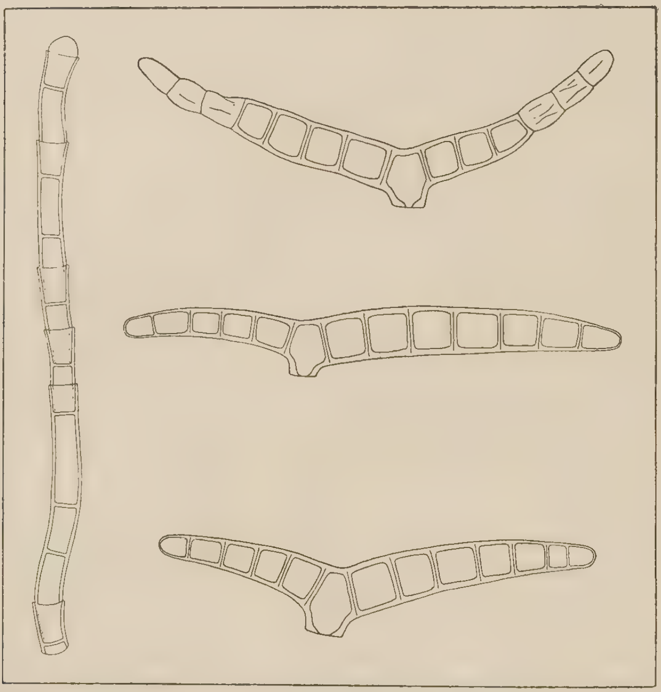


Fig. 3. *Ceratosporella bicornis*: conidiophore and conidia from the type collection; × 500.

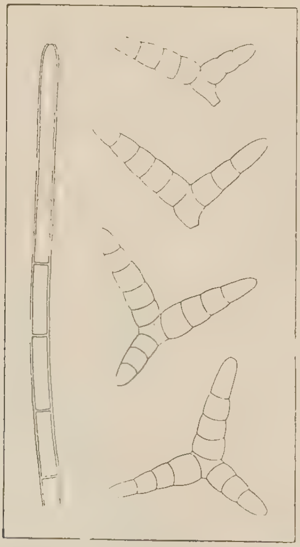


Fig. 4. *Ceratosporella* sp.: conidiophore and conidia from collection in Herb. R.B.G. Kew sub '*Triposporium elegans* Corda, with *Microthyrium*, 2437 on *Quercus* [leaves], Harkness'; × 500.

Speira stipitata differs from *S. toruloides*, the type species of *Speira* Corda (1837), in its well-differentiated conidiophores and in its conidial development. *S. toruloides* is known in Herb. I.M.I. from some thirty-four collections on wood and bark and fifteen collections on herbaceous substrata. In *S. toruloides* the conidial arms develop singly and successively by the meristematic growth and septation of a wedge-shaped cell; this latter cell has its narrow end towards the conidiophore, the distal end being curved, and successive septa are laid down to left and to right, parallel in turn with the two divergent opposite sides of the wedge-shaped cell. The cells thus cut off from the meristematic cell develop into the septate arms; eventually the meristematic cell itself develops into a short, septate arm so that at maturity the conidium is a more or less flat plate of usually five to seven conidial arms indicating four to six divisions of the meristematic cell; the individual arms are free for most of their length but generally closely adpressed to one another.

In *S. stipitata* the two to five arms arise independently of one another from the apex of the conidiophore or its proliferations which is cut off as the basal cell of the conidium.

S. stipitata may be held as generically distinct from *Cattanea heptaspora*, known to me only from the original diagnosis and figures, by the presence in the former of well-differentiated conidiophores; nevertheless there are certain similarities.

It is considered that *Ceratosporella* v. Höhnel is a suitable genus for *Speira stipitata*. The type species of v. Höhnel's genus, *Ceratosporella bicornis* (Morgan) v. Höhnel (≡*Triposporium bicorne* Morgan), has been redescribed from the type collection (Hughes, 1951) and another presumed new species of *Ceratosporella* was also described, but not assigned to a binomial. Parts of the figures published in 1951 are reproduced here (Figs. 3, 4) to indicate the relationship between the fungi from which they were drawn and *Speira stipitata*.

Comparison of the illustrations shows that all three species have long well-differentiated conidiophores. Solitary apical dematiaceous stauroconidia develop by the blowing out of the apex of the conidiophore, and of its subsequent successive proliferations in two of them, viz. *Ceratosporella bicornis* and *C. stipitata*. The conidium consists of a central basal cell from which conidial arms develop, two widely divergent ones in *C. bicornis*, two to three slightly upwardly directed arms in *Ceratosporella* sp. and two to five (mostly three to four) usually adpressed arms in *C. stipitata*.

REFERENCES

Corda, A. C. J. (1837). *Icones fungorum*, **1**, 9.

Garovaglio, S. (1875). Di alcuni nuovi funghi parassiti.... *R.C. Ist. lombardo*, Ser. 2, **8**, fasc. 4, 125.

Goidànich, G. (1934). Miceti bolognesi. *Malpighia*, **12**, 38.

Hughes, S. J. (1951). Studies on micro-fungi, XI. *Mycol. Pap., Commonw. mycol. Inst.*, **46**, 22–25.

Lindau, G. (1910). In *Rabenhorst's Kryptogamen-Flora*, 2 Aufl., I (Pilze), **9**.

(*Accepted for publication* 1 *December* 1951)

EFFECT OF PARTIAL STERILIZATION BY STEAM OR FORMALIN ON DAMPING-OFF OF SITKA SPRUCE

By J. H. WARCUP, *Botany School, University of Cambridge**

(With Plate 11 and 1 Text-figure)

Three species of *Pythium* isolated from alkaline soil of an old established nursery at Ampthill were found to be parasitic to Sitka spruce seedlings. Symptoms varied from typical damping-off to a slow root-rot. Not all infected seedlings died, some surviving as stunted plants with partly diseased root systems. Pathogenic *Pythium* species were common in nursery soil at Ampthill, but absent from forest soil there, while pathogenic and non-pathogenic species were more abundant in the old than in the newer sections of the Kennington nursery. *P. ultimum* was abundant in soil from three alkaline nurseries (pH 6·8–7·2) and rare or absent in soil from two acid nurseries (pH 5·3–5·5).

The effect of partial sterilization of nursery soil at Ampthill was, in part, to destroy pathogens. *Pythium* did not survive either the initial steam or formalin treatment, and subsequent recolonization of treated soil was slow. Formalin was highly toxic to *Pythium* species in agar cultures and in soil. *Trichoderma viride*, which is more tolerant of formalin than most other soil fungi, was often the dominant recolonizer of formalin-treated soil.

Steam or formalin treatment markedly improved numbers and height of Sitka spruce seedlings in the first year after treatment and showed a moderate residual effect in the second year, but gave little improvement in the third year.

INTRODUCTION

During recent years Sitka spruce and other conifer seedlings have shown very poor growth in many old established forest nurseries in Great Britain. Fertilizers alone have had little effect on productivity, whereas partial sterilization has increased it (Crowther, 1950). Partial sterilization is known to affect the physical properties of soil, to increase the solubility of nutrients, and to cause profound changes in the soil microflora and fauna, but there is little information about the way in which these changes affect the growth of conifer seedlings.

The effect of partial sterilization by steam or formalin on the fungus flora of an old forest nursery soil was studied at the Forestry Commission's Old Ampthill Nursery, Bedfordshire, where the seedlings have been raised for about 25 years, Sitka spruce showing very poor growth in the more recent years. Seedlings from steamed or formalin-treated plots are taller, sturdier and have much larger root systems than plants from untreated plots. Warcup (1951*b*) showed that in this nursery soil fungi were initially destroyed or reduced to very low numbers by steam or formalin treatments and that subsequent fungal recolonization of treated soil was slow.

---

* Now Senior Microbiologist, Waite Agricultural Research Institute, Adelaide, South Australia.

The common agents of conifer damping-off hitherto described are *Pythium* species, *Corticium solani* (*Rhizoctonia solani*), with species of *Fusarium* and *Phytophthora* active in certain localities (Rathbun-Gravatt, 1931; Roth & Riker, 1943). *Fusarium* and *Pythium* species are common in Ampthill nursery soil (Warcup, 1951*b*), but little is known about the identity of the pathogens in Great Britain. Hartley (1921) and others have pointed out that damping-off in forest nursery beds is in many cases primarily a root-rot.

GROWTH OF SITKA SPRUCE SEEDLINGS IN THE NURSERY

During 1950, Sitka spruce (*Picea sitchensis* Carr.) seedlings grown in untreated plots at Ampthill (Warcup, 1951*b*) were examined for the occurrence of damping-off. Seed of Sitka spruce was sown on 20–21 March and germination commenced about a month later. Examination of seed-beds 3–7 weeks after germination showed a few seedlings with typical damping-off symptoms. A greater number, however, died gradually and stood upright, shrivelled and brown, in the nursery beds. The number of seedlings which had died increased until mid-July, by which time an estimated 70–80% of the seedlings had died. Few seedlings died after July but those which survived remained small and were typical of Sitka spruce grown in a 'conifer sick' old established nursery. In May–June seedlings from sterilized soil had clean, white roots, whereas most of those from untreated soil showed all degrees of damage from small lesions to a chestnut-brown discoloration of the entire root system. Lesions were not confined to ground-level but occurred at various points throughout the length of the root. Discoloured roots were often shrivelled and decayed for a greater or lesser part of their length. Seedlings with extensively damaged roots usually showed a shrivelling of the stem before death. Older seedlings had secondary roots arising above the decayed root portions, often with subsequent damage to these secondary roots.

ISOLATION OF FUNGI FROM SITKA SPRUCE SEEDLINGS

Throughout the 1950 growing season fungi were isolated from living Sitka spruce seedlings grown in untreated plots. The whole roots were washed, sterilized for 3 min. in 1 in 1000 mercuric chloride, washed three times in sterile water and plated on Dox + yeast agar. Table 1 records the fungi most commonly isolated; the value of 100 for percentage occurrence means that a particular fungus was isolated from every root.

Table 1. *Percentage occurrence of fungal isolates from roots of Sitka spruce seedlings grown in untreated nursery plots*

Date of sampling ...	24 May	30 May	6 June	26 June	24 July	15 August
No. of seedlings examined ...	22	82	80	100	55	25
Common fungi isolated:						
Pythium spp.	36	40	18	2	0	4
Fusarium spp.	5	27	53	100	55	72
Cylindrocarpon radicicola	9	20	7	30	52	60
Penicillium spp.	9	0	5	3	37	16
Chaetomium spp.	9	2	6	3	22	28

Table 1 shows that *Pythium* species were commonly recorded in spring but were rarely isolated later in the year. Most of the other fungi isolated increased throughout the growing season. Three species of *Pythium* (*P. ultimum* Trow, *Pythium* E39 and *Pythium* E16) and two strains of *Fusarium oxysporum* sensu Snyder & Hansen were the fungi most commonly isolated, but other species of these genera were occasionally recorded.

PATHOGENICITY OF ISOLATES OF *PYTHIUM* AND *FUSARIUM* TO SITKA SPRUCE SEEDLINGS

The pathogenicity to Sitka spruce of *Cylindrocarpon radicicola* Wollenw., and of all species of *Pythium* and *Fusarium* isolated from seedlings or soil at Ampthill was tested in the laboratory. One-pound jars were filled with sterilized Kettering loam potting soil of pH 6·0. Seventeen cultures were tested. Three jars were allowed for each culture and six jars for controls. For inoculation, 0·6 cm. disks cut from the edges of actively growing fungal colonies upon Dox+yeast agar were used. One disk was placed about 1 cm. below the level of the seed-bed in each jar. Each jar was sown with fifty seeds. The seeds were covered with a $\frac{3}{16}$ in. layer of a coarse, unsterilized sand, as the use of a coarse seed-bed cover is normal nursery practice. This sand had been tested and found to be free from *Pythium* and *Fusarium*. Throughout the experiment, the soil was maintained at 45% of its water holding capacity by frequent weighing and by adding water as necessary. Damped-off seedlings were removed with sterile forceps at intervals up to a month. All seedlings plated on agar yielded the inoculated fungus. The results are given in Table 2. The experiment was later repeated with Ampthill soil when the *Fusarium* inoculum consisted of the fungus grown for 1 month on maize-meal-sand (3:100) medium. Two grams of inoculum were incorporated with the

Table 2. *Pathogenicity of isolates of* Pythium, Fusarium *and* Cylindrocarpon *to Sitka spruce seedlings*

Fungus	Emergence (%)	Post-emergence loss (%)	Total loss* (%)
Pythium ultimum Trow	65	94	95
Pythium E16	63	85	88
Pythium E16 strain *b*	68	56	62
Pythium E39	69	90	91
Pythium E39 strain *b*	67	97	98
Pythium E24	79	0	1
Pythium ? acanthicum Drechsler	85	0	0
P. dissotocum Drechsler	81	0	0
P. rostratum Butler	84	0	0
P. intermedium de Bary	77	0	4
Pythium E150	87	0	0
Fusarium oxysporum strain 1	73	1	10
F. oxysporum strain 2	83	0	0
F. culmorum (W. G. Smith) Sacc.	82	0	0
F. equiseti (Corda) Sacc.	76	0	5
F. sambucinum Fuckel	80	0	0
Cylindrocarpon radicicola Wollenw.	81	0	0
Control	80	0	0

* Expressed as percentage of seedlings emerging in controls.

soil at seed level in each jar. The results of this experiment were similar to those reported in Table 2, except that the percentage seed germination in soil inoculated with pathogenic species of *Pythium* was lower.

Three species of *Pythium* were thus highly pathogenic to Sitka spruce seedlings grown in steam-sterilized soil. The *Fusarium* strains and *Cylindrocarpon radicicola* were apparently of little importance, for experiments with *Pythium* and *Fusarium* isolates inoculated together into soil showed that while both could be isolated from seedlings after 2–3 weeks no seedling yielded *Fusarium* alone, and the presence of *Fusarium* did not increase the severity of the disease.

From these and similar experiments it has been found that the *Pythium* species studied caused a wide range of disease symptoms in Sitka spruce, depending on the moisture content of the soil. *P. ultimum* was generally the most virulent species; at low soil moisture it caused a root-rot which gradually killed seedlings and left them standing upright. At high soil moisture infected seedlings showed typical damping-off symptoms and rotted rapidly. In sterilized Ampthill soil kept at 70% of its water-holding capacity, *P. ultimum* caused pre-emergence losses ranging between 70 and 100%, all surviving seedlings being killed within 10–14 days of emergence. The symptoms caused by *Pythium* E16 also varied with soil moisture; in many of the infected seedlings, only the curved hypocotyls appeared above the ground. These curved seedlings often stayed green for appreciable periods, the stem being apparently resistant, though the root was attacked soon after emergence from the seed coat. *Pythium* E39 typically caused heavier post-emergence than pre-emergence losses irrespective of soil moisture, and in general attacked the seedlings at a later stage than the other two fungi (Pl. 11, figs. 3, 4), causing a root-rot.

Table 3. *Damping-off of Sitka spruce seedlings grown in untreated Ampthill soil kept at different moisture contents*

	Moisture content as percentage water-holding capacity			
	15–20	35–40	55–60	75–80
Percentage emergence of seedlings	0*	64	76	26
Percentage post-emergence loss	0	84	93	100

* Seed healthy, soil too dry for germination.

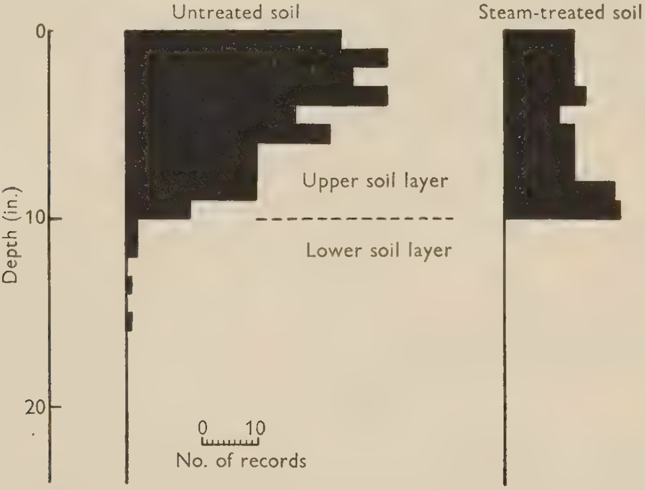
In pathogenicity experiments spruce seedlings which survived 1 month after inoculation were kept for a further 6 weeks. Deaths continued up to the end of that period. Surviving seedlings from *Pythium*-infected soil were significantly smaller than seedlings of the same age from uninfected controls. In seedlings from *Pythium*-infected soil the primary roots were generally decayed and secondary roots originated above the region of decay. A few secondary roots were also decayed. Height of seedlings was approximately inversely proportional to the length of root infected.

The loss caused by *Pythium* species present in untreated naturally contaminated Ampthill nursery soil is shown in Table 3, which records losses of seedlings in soil kept at different moisture levels in the laboratory. The seed used gave an 80% germination in sterilized soil.

Even at comparatively low soil moisture contents damping-off losses, particularly post-emergence losses, were very heavy in naturally contaminated Ampthill nursery soil. This experiment has been repeated over the lower soil moisture range (35–40 % of water-holding capacity) with post-emergence losses ranging between 42 and 95 %.

OCCURRENCE OF *PYTHIUM* IN NURSERY SOIL

Warcup (1951*b*) showed that *Pythium* species (pathogenic and non-pathogenic) were widespread throughout the upper layer and rare in the lower layer of Ampthill nursery soil. An analysis of their occurrence on soil plates (Warcup, 1950) from soil samples collected over a period of 3 years showed that they were recorded most abundantly from a depth of 2–4 in., and that below 6 in. their numbers fell off to a depth of 10–12 in., the limit of the upper soil layer (Text-fig. 1). Only four colonies of *Pythium* on some 540 soil plates were recorded from the lower soil layer, and the deepest level at which a *Pythium* colony was found was 16 in. There was some evidence that *Pythium* species occurred less frequently in the top inch or two of soil in summer than in winter. This accords with the findings of McLaughlin (1947). The species isolated most commonly was *Pythium* E16. *P. ultimum*, *Pythium* E39, *Pythium* E24, *P. intermedium* and *P.* ? *acanthicum* were isolated frequently, and other species were rare. *Pythium* E150 was recorded only from larger humus particles which had been washed free from other soil particles.



Text-fig. 1. Occurrence of *Pythium* in profiles of untreated and recolonized steam-treated nursery soil.

To find out whether *Pythium* species were present as spores or mycelium in nursery soil, a study of the source of *Pythium* colonies developing on soil plates was made by the method outlined by Warcup (1951*a*). Soil plates were prepared and incubated at 22·5° C. for 12–24 hr. and then examined for the presence of *Pythium* colonies. Widely spaced colonies coming from arger soil particles were cultured by removing a hyphal tip to an agar slope. The remainder of the colony with a surrounding block of agar was cut out and placed on a microscope slide. Most of the agar around the colony was carefully cut away, the remaining agar and colony were stained with lactophenol-cotton blue diluted 1 : 10 with water, and a cover-slip added. Some care was necessary to avoid breaking the colony into pieces, but if the agar disintegrated under the weight of the cover-slip a good preparation usually resulted. Preparations were sealed with gum dammar-beeswax sealing compound (Dade & Waller, 1949).

Some 55 *Pythium* colonies were mounted on slides; others were examined without being made into preparations. Most colonies were isolated from soil from Tair Onen nursery, Glamorgan, Wales, but a few were from Ampthill. All the *Pythium* colonies had originated from spores, but whether from oospores, or resting sporangia was often difficult to decide. Oospores were sometimes found still surrounded by the oogonium wall (Pl. 11, fig. 1). Most spores were found to be surrounded by, and sometimes deeply embedded in, a mass of small humus and clay particles, the whole mass being irregular in outline (Pl. 11, figs. 1, 2). Unless a stained germ tube and spore contents could be seen, it was often difficult to determine whether such masses contained a *Pythium* spore or not.

Although it is reported that oospores of *Pythium* are difficult to germinate (Middleton, 1943), it is notable that in these experiments oospores germinated easily. *Pythium* spores are often surrounded by soil particles to form relatively large masses which may be the reason why *Pythium* species are not usually recorded in soil dilution studies (Chesters, 1949). High dilutions would also tend to obscure the presence of *Pythium* in soil.

Since *Pythium* species were of common occurrence in nursery soil, an examination was made of soil from the conifer forest at Ampthill. Soil samples were collected from the upper 6 in. of twelve profiles from different parts of the forest and the fungal floras of these profiles examined. *Pythium* species were found in a grass ride between forest sections, and in a section of pines grown after deciduous trees, a few of which were still present. They were not recorded from pure pine stands or under Douglas fir where the soil was more acid than elsewhere. All *Pythium* isolates recorded from forest sections were found to be non-pathogenic to Sitka spruce seedlings.

Effect of partial sterilization on the occurrence of *Pythium* species in nursery soil

Both with steam and with formalin treatment, fungi in Ampthill nursery soil were initially destroyed or reduced to very low numbers (Warcup, 1951*b*). The penetration of soil was 16 in. for Hoddesdon steaming and 5 in. for formalin treatment. Subsequent fungal recolonization of treated soil was very slow and different under the different treatments. Steam-treated soil was recolonized chiefly by species of *Mortierella*, *Phoma eupyrena* and *Coniothyrium* in the first year, whereas *Trichoderma viride* was the dominant recolonizer of formalin-treated soil in the same period.

There was no evidence that *Pythium* species survived the initial partial sterilization treatments, and their recolonization of treated soil was relatively slow. Table 4 records the occurrence of *Pythium* species at Ampthill over a period of 3 years after soil treatments with steam and formalin in March 1949. These records represent total *Pythium* (pathogenic and non-pathogenic) since most colonies were recorded without isolation. Occurrence throughout the year has been divided into two periods 'spring' (March to July) and 'autumn' (August to November). No samples were collected during December to February. Damping-off of Sitka spruce in the nursery occurred predominantly in the spring period of the year.

Pythium species were first recorded from steam-treated soil 13 weeks after treatment, and recolonization was very slight during the first spring. Their numbers rose in the autumn, remained at that level throughout the second spring, showed a further increase in the second autumn, and were at a level comparable with that recorded in untreated plots in the third spring after treatment. Not all of the colonies of *Pythium* from steamed plots were isolated and identified. *Pythium* E16, *P. ultimum* and *Pythium* E24, however, were isolated in the second year and six species, including the three pathogenic species, were recorded in the third year after treatment. Damping-off was not noted in these steamed plots during 1949, was sporadic in 1950 and serious in 1951.

Table 4. *Effect of partial sterilization treatments on subsequent occurrence of* Pythium *in nursery soil*

	Percentage of soil plates on which *Pythium* recorded				
	1949		1950		1951
Treatment—March 1949	Spring	Autumn	Spring	Autumn	Spring
Steam, Hoddesdon	0·5	8	10	33	41
Formalin, treated zone, 0–5 in.	0	0	3	6	—
Formalin, upper layer, 0–10 in.	15	11	21	17	20
Untreated	33	30	46	37	40

In a further series of nursery plots at Ampthill which were steamed by the Hoddesdon method in 1950, *Pythium* species were not recorded during the spring period and were present on only 2% of the plates during the autumn period.

By the end of the second year after treatment a difference was noted in the location of *Pythium* in profiles of steamed plots when contrasted with untreated plots. Whereas in untreated soil, *Pythium* species were most frequently recorded from 2 to 4 in. deep, in steamed soil they were most frequently isolated from 8 to 10 in. deep. Text-fig. 1 shows histograms of the numbers of plates from profiles of steamed and untreated soil from which *Pythium* species were recorded.

Table 4 shows that *Pythium* species were not recorded from treated soil until 12 months after the application of formalin. They were, however, still present in the untreated soil below the level of formalin penetration. During the second year their numbers remained low in the treated soil zone. At the end of the second year, the plots were cultivated to a depth of 7–8 in. so that the treated soil layer was broken up and the surface soil layers contained a mixture of untreated and formalin-treated soil.

In nursery plots treated with formalin in 1950, *Pythium* species were not recorded during the spring period and were present on 4% of the soil plates during the following autumn.

Table 5 records the growth of Sitka spruce seedlings on these plots over the period of 3 years after the soil treatments (assessments through the courtesy of the Forestry Commission). Partial sterilization treatment by steam or formalin greatly improved the height and number of seedlings in the first year, gave a considerable residual effect in the second year, and showed little improvement in the growth of Sitka spruce seedlings in the third year after treatment. Losses of seedlings throughout all plots were much greater in 1950 and 1951 than in 1949.

Table 5. *Effect of partial sterilization by steam or formalin on growth of Sitka spruce seedlings in old forest nursery soil*

	1949		1950		1951	
Treatment, March 1949	Total no. of seedlings per sq.yd.	Mean height in in.	Total no. of seedlings per sq.yd.	Mean height in in.	Total no. of seedlings per sq.yd.	Mean height in in.
Steam (Hoddesdon)	801	2·46	241	1·6	182	0·48
Formalin	774	1·84	217	1·18	190	0·56
Untreated	373	1·03	60	0·97	86	0·34

EFFECT OF FORMALIN ON SOIL FUNGI

Formalin treatment of soil in the nursery at Ampthill increased *Trichoderma viride* (Warcup, 1951 *b*) and decreased *Pythium*. The effect of different concentrations of formalin on soil fungi was, therefore, tested in soil and in agar cultures. Different concentrations of formalin were added to a Kettering loam potting soil and to the Ampthill soil in glass tumblers (Garrett, 1936) in the laboratory. Formalin applied at the rate of 0·1 gal. of commercial formalin per sq.yd. (made up in 1 gal. of water) killed all fungi in the top layers of Ampthill soil in field plots, so the equivalent amount (0·35 ml./sq.in.) was used as a standard, 'S', for dilution studies. Progressively reduced fractions of the standard in a specified volume of water (enough to bring air dry soil to 50% water-holding capacity) were added to 150 g. lots of air dry soil in glass tumblers. After addition of formalin, tumblers were closed with moisture-proof cellophane covers and left for 2 days. Tumblers were sampled at a depth of 1 in. by the soil-plate method, three plates being prepared from each tumbler. After sampling, tumblers were sown with cress seed to measure the toxicity of different concentrations of formalin and to note any damping-off of cress seedlings by *P. ultimum*. Table 6 records the results of these experiments which have been repeated with the same general results. The results were, however, rather variable and sometimes the same strength of formalin killed more fungi than on other occasions.

Table 6 shows that at certain concentrations formalin may act as a true 'partial' sterilizing agent, killing some fungi but not others. In these soils *Penicillium* species (*P. luteum*, *P. wortmanni* and *P. purpurogenum*) were usually the most resistant fungi to formalin. They were followed by

Trichoderma viride, *Fusarium* species, *Phoma eupyrena*, and *Botrytis* among others. *Pythium ultimum* appears very susceptible to formalin, since damping-off was prevented at formalin concentrations which left most other soil fungi still viable. In confirmation of a previous report by Haenseler (1935), Ogilvie, Hickman and Croxall (1938) found formalin diluted 1/200–1/600 would control damping-off of various seedlings if added after the seed was sown. Some seedling injury also occurred, especially to seedlings of *Matthiola* at the lower dilutions.

Table 6 shows that Kettering loam treated with certain concentrations of formalin was rapidly recolonized by *Trichoderma viride*, which spored profusely and visibly throughout the soil after 7–10 days at laboratory temperatures. Soil plates showed that *T. viride* also recolonized Ampthill soil after the application of certain concentrations of formalin, but visible fructifications on soil were not observed. *T. viride* did not recolonize soil after the more concentrated or the more dilute doses of formalin. This may have been due either to the fact that formalin in high concentrations was toxic to the fungus or that *T. viride* had been killed throughout the tumblers. With dilute doses of formalin the abundance of *T. viride* decreased as the dilution of the solution increased and appeared inversely proportional to the number of other fungi present in the soil. It would appear that unless a certain proportion of the soil microflora was killed by the formalin *T. viride* did not abundantly recolonize the soil. Davey and Leach (1941), using formalin to control *Sclerotium rolfsii* in soil, found *Trichoderma* appearing upon considerable numbers of the sclerotia after formalin treatment. The percentage of sclerotia from which *Trichoderma* grew decreased as the dilution of the solution used for treating the soil increased. They supposed that *Trichoderma* invaded sclerotia killed or weakened by chemical treatment. Bliss (1951), in a study of the control of *Armillaria mellea* root-rot of citrus by partial soil sterilization with carbon disulphide, has correlated the death of *A. mellea* with the development of *Trichoderma viride* in soil after partial sterilization. Fumigation with CS_2 in sterilized soil did not kill *Armillaria mellea* in citrus root segments. *Trichoderma viride*, however, when grown in sterilized soil killed the fungus

Table 6. *Effect of different dilutions of formalin on occurrence of fungi in soil and on growth of cress seedlings*

	Kettering loam			Ampthill soil		
Formalin dilution	Av. no. of species of fungi	Growth of cress	Visible fructifications of *Trichoderma viride*	Av. no. of species of fungi	Growth of cress	Visible fructifications of *Trichoderma viride*
S	0	No germination	–	0	No germination	–
S/4	0	No germination	–	0	No germination	–
S/10	1	No germination	+++	0	No germination	–
S/20	3	Seedling injury	+++	3	Seedling injury	–
S/40	8	Seedling injury	++	6	Seedling injury	–
S/60	11	Normal growth	+	10	Normal growth	–
S/100	19	Normal growth	–	21	Normal growth	–
S/200	22	Normal growth	–	29	Damping off	–
Control	24	Normal growth	–	28	Damping off	–

even without fumigation. In roots in unsterilized soil containing *T. viride* and other fungi, *Armillaria mellea* remained viable when not fumigated, but was killed when fumigated, *Trichoderma viride* showing rapid development in the fumigated soil.

The effect of formalin on growth of soil fungi in agar culture was also examined. 1 ml. amounts of dilutions of formalin were placed in sterile Petri dishes, 10 ml. of cooled Dox + yeast agar (pH 5·0) were added and the plates then inoculated with 2 mm. squares of actively growing cultures of various soil fungi and incubated at 22·5° C. for 2–8 days. Table 7 shows the growth of each fungus recorded on an index of 0–10 where 10 is growth made on formalin-free agar.

Table 7. *Growth in culture of soil fungi in presence of dilutions of formalin*

	Dilutions of commercial formalin							
Fungus	1:100	1:250	1:500	1:750	1:1000	1:1500	1:2000	1:2500
Pythium E16	0	0	0	0	0	0	0	7
P. intermedium	0	0	0	0	0	0	0	2
Mortierella E23	0	0	0	0	0	0	0	5
Mortierella E31	0	0	0	0	0	0	1	—
Pythium E39	0	0	0	0	0	0	2	4
Pythium E24	0	0	0	0	0	0	4	4
P. ultimum	0	0	0	0	0	0	3	—
Phytophthora erythroseptica	0	0	0	0	0	0	8	7
Chaetomium globosum	0	0	0	1	3	5	6	—
Phoma eupyrena	0	0	9	10	10	10	10	10
Cylindrocarpon radicicola	0	0	9	10	10	10	10	10
Penicillium jenseni	0	0	9	10	10	10	10	10
P. nigricans	0	2	7	10	10	10	10	—
Botrytis cinerea	0	1	10	10	10	10	10	—
Fusarium equiseti	0	6	9	10	10	10	10	—
F. culmorum	0	7	8	9	10	10	10	—
F. oxysporum strain 1	0	8	10	10	10	10	10	—
Trichoderma viride	0	0	3	10	10	10	10	—
T. viride B	1	8	9	10	10	10	10	—

Note: *Pythium dissotocum*, *Pythium* E150, *P.* ? *acanthicum*, and *P. rostratum* were inhibited by all dilutions of formalin. 1–50 formalin inhibited all fungi.

All *Pythium* species tested were sensitive to the presence of formalin in agar culture; other fungi such as *Fusarium* species and *Trichoderma viride* were much more tolerant. The results also show good agreement with the data obtained from nursery and laboratory experiments with fungi in soil. *Botrytis cinerea* showed an apparent stimulation of growth in agar containing 1:500 formalin.

Following upon these results, dilute formalin has been used to control *Pythium* which was masking the presence of other soil fungi developing from humus particles plated in agar. After dilute formalin treatment of the particles before plating, the number of plates showing *Pythium* colonies dropped from 10 in 12 to 1 in 12 with little apparent loss, and much easier recognition, of other soil fungi present in humus particles.

OCCURRENCE OF *PYTHIUM* SPECIES IN OTHER FOREST NURSERY SOILS

Since *Pythium* species were common in nursery soil at Ampthill but rare in forest soil, soil samples from other forest nurseries were obtained in 1951 to investigate their *Pythium* content. Most samples were obtained from old established nurseries or nursery sections where difficulty is experienced in growing Sitka spruce, though a few were from newer nursery sections in which growth was moderate or good. Soils were examined only for the occurrence of *Pythium* species.

Sections of different ages of a forest nursery soil from Kennington nursery, near Oxford, were examined. The oldest section (K 1/5) had been in use since 1925 and now gives poor growth of Sitka spruce, the second section (K2D), from the nursery extension, had been in use since 1945 and shows moderate growth, and the third section, in which conifers had not yet been grown, K3A, was agricultural soil recently incorporated into the nursery. Soil samples were collected some yards apart and from a depth of 2–4 in. on two different occasions during the summer, and counts made on the numbers of colonies of species of *Pythium* in 0·25 g. portions from each sample. Twenty soil plates from each sample were prepared using a total of 0·25 g. of soil, measured by weighing before and after preparation of soil plates, and the number of colonies of *Pythium* developing on these plates was counted. Plates were incubated at 22·5° C. and colonies counted after 1–4 days using a binocular dissecting microscope. Hyphal tips of colonies were tubed and the species determined. Table 8 records numbers of colonies of *Pythium* spp. isolated from the three sections. Samples 3–7 were collected on 22 June 1951, and samples 8 and 9 on 26 July 1951, the moisture contents of the latter samples being much lower than those of the former. Table 8 shows that the number of colonies and the number of species of *Pythium* were highest in the oldest section. This section was also alkaline whereas the newer sections were acid. *P. ultimum* was common in the old section, rare and sporadic in the nursery extension and was not isolated from the agricultural section. E 16, however, was much more abundant in the agricultural section than in the sections in which conifers have been grown. The pathogenicity of many of these isolates to Sitka spruce was determined and is shown in Table 10.

The *Pythium* species present in soil of other old established nurseries (Tair Onen, Wales; Tulliallen, Fife; Ringwood, Hants) which gave poor growth of Sitka spruce have been determined by the same method, and the results are given in Table 9. Numbers of colonies of different species were counted, but it is not known whether it is possible to correlate 'numbers of colonies' from different soils under different crops and with different moisture contents, in more than a general way. The number of counts made was small (3–4 except with Kennington), and it is possible that other species of *Pythium* are present in these soils but were not isolated. Since E39 was isolated relatively more frequently from damped-off seedlings than from soil plates at Ampthill, it is possible that this or other pathogenic *Pythium* species might be isolated from diseased seedlings from these other nurseries.

Table 9 shows that Ampthill, the old section of Kennington (K 1/5), and Tair Onen nursery soils contain similar *Pythium* species, both pathogenic and non-pathogenic. These nurseries, or at least the parts investigated, are also all alkaline. Fewer species of *Pythium* were obtained from Old Ringwood and Tulliallen nurseries, which have acid soils, than from the alkaline soils in Ampthill, Kennington and Tair Onen. The lists from Old

Table 8. *Numbers of colonies and species of* Pythium *isolated from soil from three sections of Kennington nursery*

Nursery section	K1/5								K2D								K3A							
Age of section (years) ...	27								7								0							
Crop in 1950 and 1951 ...	Fallow								Fallow								Fallow							
pH of section (A.V.) ...	7·2								5·9								5·0							
Sample no.	3	4	5	6	7	8	9	Totals	3	4	5	6	7	8	9	Totals	3	4	5	6	7	8	9	Totals
Weight of soil used (g.) ...	0·26	0·25	0·24	0·27	0·25	0·25	0·26	1·78	0·25	0·25	0·28	0·26	0·25	0·27	0·25	1·80	0·25	0·26	0·25	0·26	0·27	0·26	0·25	1·80
Pythium E16*	13	14	9	5	4	7	3	55	5	4	5	3	5	9	3	34	15	17	21	21	25	7	7	113
Pythium E24	20	34	37	18	28	10	14	161	1	2	6	1	1	5	3	19	0	0	0	1	3	0	0	4
P. intermedium	4	13	5	6	1	3	2	34	4	7	12	2	4	1	1	31	2	0	0	0	0	1	0	3
Pythium K1. 1	19	11	5	11	3	1	5	55	1	1	4	0	0	0	0	6	0	0	0	0	0	0	0	0
P. ? acanthicum	0	0	5	4	10	6	11	36	0	0	0	0	0	2	3	5	0	0	0	0	0	0	2	2
*P. ultimum**	15	9	6	8	18	19	12	87	0	2	0	0	1	1	0	4	0	0	0	0	0	0	0	0
Pythium K1.6	0	1	2	1	0	0	1	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pythium K1.14	1	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	72	82	69	54	64	46	48	435	11	16	27	6	11	18	10	99	17	17	21	22	28	8		122

* Species pathogenic to Sitka spruce.

Table 9. *Occurrence of* Pythium *species in forest nursery soils*

Nursery section	Ampthill	Kennington K1/5	Tair Onen	Tulliallen	Ringwood old	Kennington K2D
Crop in 1951	Sitka spruce	Fallow		Fallow	Fallow	Fallow
Av. pH of samples ...	7·1	7·2	7·2	5·3	5·5	5·9
% moisture content ...	12·0	15·8	19·5	18·8	9·4	15·0
Pythium ultimum	c.	c.	a.	—	r.	r.
Pythium E16	a.	c.	c.	a.	c.	c.
Pythium E39	c.	—	—	—	—	—
Pythium E24	c.	a.	c.	—	—	c.
P. ? acanthicum	c.	c.	r.	—	—	r.
P. dissotocum	r.	—	—	—	—	—
P. rostratum	r.	r.	r.	—	—	—
P. intermedium	c.	c.	c.	—	—	c.
Pythium E150	r.	—	—	—	—	—
Pythium K1.6	—	r.	r.	—	—	—
Pythium K1.1	—	c.	—	—	—	r.
Pythium Tul.1.11	—	—	—	r.	—	—
Pythium R1.11	—	—	—	—	c.	—
P. mamillatum Meurs	—	—	—	—	c.	—
Pythium R1.6	—	—	—	—	r.	—

a. = abundant; c. = common; r. = rare.

Table 10. *Pathogenicity of* Pythium *species isolated from forest nursery soils to Sitka spruce seedlings*

Experiment	A		B		C	
Soil	Kettering loam		Ampthill		Ampthill	
Soil moisture (% W.H.C.)	45		50		50	
	Sitka spruce		Sitka spruce		Sitka spruce	
Fungus	Emergence (%)	Post-emergence loss (%)	Emergence (%)	Post-emergence loss (%)	Emergence (%)	Post-emergence loss (%)
Pythium ultimum K1	68	65	—	—	—	—
P. ultimum T	—	—	53	100	—	—
P. ultimum R	—	—	—	—	33	100
Pythium E16 K1	56	98	—	—	—	—
Pythium E16 K3	65	98	—	—	—	—
Pythium E16 Tul.	—	—	57	95	—	—
Pythium E16 R	—	—	—	—	50	78
Pythium E16 T	—	—	31	90	—	—
P. ? acanthicum K1	92	0	—	—	—	—
P. ? acanthicum T	—	—	83	0	—	—
Pythium E24 K1	85	0	—	—	—	—
Pythium E24 T	—	—	86	0	—	—
P. intermedium K1	87	0	—	—	—	—
P. intermedium T	—	—	85	2	—	—
Pythium K1.6	91	0	—	—	—	—
Pythium K1.1	93	1	—	—	—	—
Pythium K1.14	93	0	—	—	—	—
Pythium T5.1	—	—	—	—	62	3
Pythium R1.6	—	—	—	—	68	0
Pythium Tul. 1.11	—	—	83	0	—	—
Control A	89	0	—	—	—	—
Control B	—	—	85	0	—	—
Control C	—	—	—	—	64	0

K1 = Kennington K1/5; R = Ringwood; T = Tair Onen; K3 = Kennington K3A; Tul. = Tulliallen.

Ringwood and Tair Onen also differed from one another. *P. ultimum* was rare or absent in the acid nursery soils, whereas it was common or abundant in the alkaline ones. Of these soils Tair Onen had the highest number of *Pythium* colonies, ranging from 595 to 687 per g., *P. ultimum* comprising from one-half to three-quarters of the total number. Counts for this soil were made using 0·10 g. of soil per twenty plates as it was difficult to count colonies with any accuracy in larger samples. The relative pathogenicities to Sitka spruce in sterilized soil of isolates of *Pythium* from these nurseries (except for two species from Ringwood) is given in Table 10.

Since *Pythium* E16 was found to be common in Kennington K3A, the agricultural soil which had not carried a conifer crop, the incidence of damping-off in untreated soil from the different sections of Kennington nursery was investigated. Untreated soil from Tair Onen and Tulliallen was also tested in the same experiment. Soils were adjusted to approximately 50% of water-holding capacity and sown with Sitka spruce seed.

Table 11. *Percentage damping-off in untreated nursery soils*

Nursery section ...	... Kennington K1/5	Kennington K2D	Kennington K3A	Tair Onen	Tulliallen
Percentage emergence	77	90	90	38	90
Percentage post-emergence loss	74	6	3	86	6

The percentage germination and post-emergence losses over a period of 5 weeks are recorded in Table 11 which shows that damping-off was serious in Kennington K1/5 and Tair Onen, old established alkaline nursery soils containing *P. ultimum*. Damping-off was not serious in the other Kennington sections or at Tulliallen though E16, which is highly pathogenic in sterilized soil, was present in all three soils. It would appear that this species may be only mildly pathogenic under natural soil conditions or only become a serious parasite under certain environmental or nutritional conditions of the host.

This investigation was made possible by a grant kindly given by the Agricultural Research Council. Facilities for the field experiments were afforded through the courtesy of the Forestry Commission and they were carried out in co-operation with the Commission's Research Branch. I should like to express my thanks to Dr S. D. Garrett for continued encouragement, to Dr C. J. Hickman for the identification of *Pythium* isolates and to Mr F. T. N. Elborn for the preparation of photographs.

REFERENCES

Bliss, D. E. (1951). The destruction of *Armillaria mellea* in citrus soils. *Phytopathology*, **41**, 665–683.

Chesters, C. G. C. (1949). Concerning fungi inhabiting soil. *Trans. Brit. mycol. Soc.* **32**, 197–216.

Crowther, E. M. (1950). Committee on nutrition problems in forest nurseries. In *Report on Forest Research for the year ending March* 1949, pp. 60–64. London: H.M. Stationery Office.

Dade, H. A. & Waller, S. (1949). New techniques for mounting fungi. *Mycol. Pap., Commonw. mycol. Inst.*, no. 27, pp. 1–5.

Davey, A. E. & Leach, L. D. (1941). Experiments with fungicides for use against *Sclerotium rolfsii* in soils. *Hilgardia*, **13**, 523–547.

Garrett, S. D. (1936). Soil conditions and the take-all disease of wheat. *Ann. appl. Biol.* **23**, 667–699.

Haenseler, C. M. (1935). Damping-off of seedlings controlled by new method of using formaldehyde. *Agric. News Letter*, **3**, 7–8.

Hartley, C. (1921). Damping-off in forest nurseries. *Bull. U.S. Dep. Agric.* **934**, 1–99.

McLaughlin, J. H. (1947). The isolation of *Pythium* from soil at various seasons of the year as related to soil temperature and moisture. *Phytopathology*, **37**, 15.

Middleton, J. T. (1943). The taxonomy, host range and geographic distribution of the genus *Pythium*. *Mem. Torrey Bot. Cl.* **20**, 1–171.

Ogilvie, L., Hickman, C. J. & Croxall, H. E. (1938). The control of damping-off fungi by means of chemicals applied to the soil, with special reference to weak formaldehyde solutions. *Rep. agric. hort. Res. Sta. Bristol*, pp. 98–114.

Rathbun-Gravatt, A. (1931). Germination loss of coniferous seeds due to parasites. *J. agric. Res.* **42**, 71–92.

Roth, L. F. & Riker, A. J. (1943). Life history and distribution of *Pythium* and *Rhizoctonia* in relation to damping-off of red pine seedlings. *J. agric. Res.* **67**, 129–148.

Warcup, J. H. (1950). The soil-plate method for isolation of fungi from soil. *Nature, Lond.*, **166**, 117–118.

Warcup, J. H. (1951*a*). The ecology of soil fungi. *Trans. Brit. mycol. Soc.* **34**, 376–399.

Warcup, J. H. (1951*b*). Effect of partial sterilization by steam or formalin on the fungus flora of an old forest nursery soil. *Trans. Brit. mycol. Soc.* **34**, 519–532.

EXPLANATION OF PLATE 11

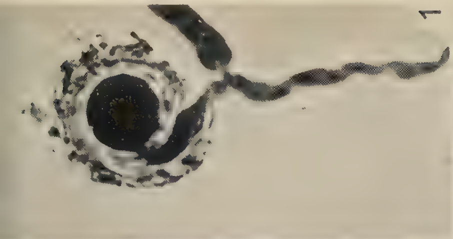
Fig. 1. Germinating oospore of *Pythium ultimum* within the oogonial wall, isolated from a soil plate. × 700.

Fig. 2. Germinating spore of *Pythium* sp. with attached soil particles isolated from a soil plate. × 700.

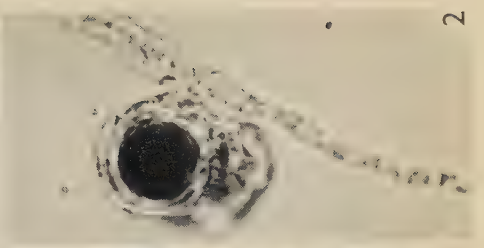
Fig. 3. Damping-off of Sitka spruce seedlings by different species of *Pythium* inoculated into steam-sterilized soil, 8 days after germination. E27 is *P. ultimum*.

Fig. 4. Damping-off of Sitka spruce seedlings by different species of *Pythium* inoculated into steam-sterilized soil, 26 days after germination. E27 is *P. ultimum*.

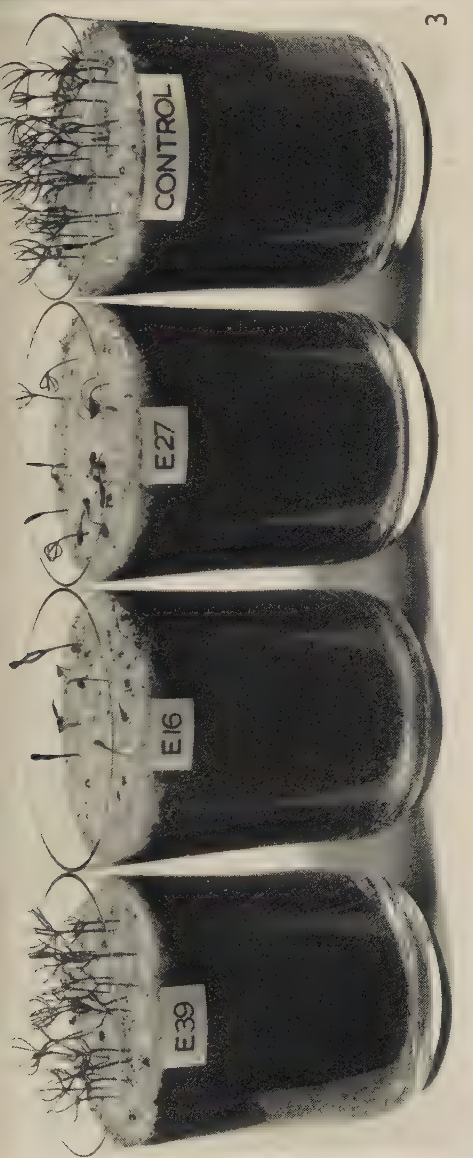
(*Accepted for publication 2 January* 1952)



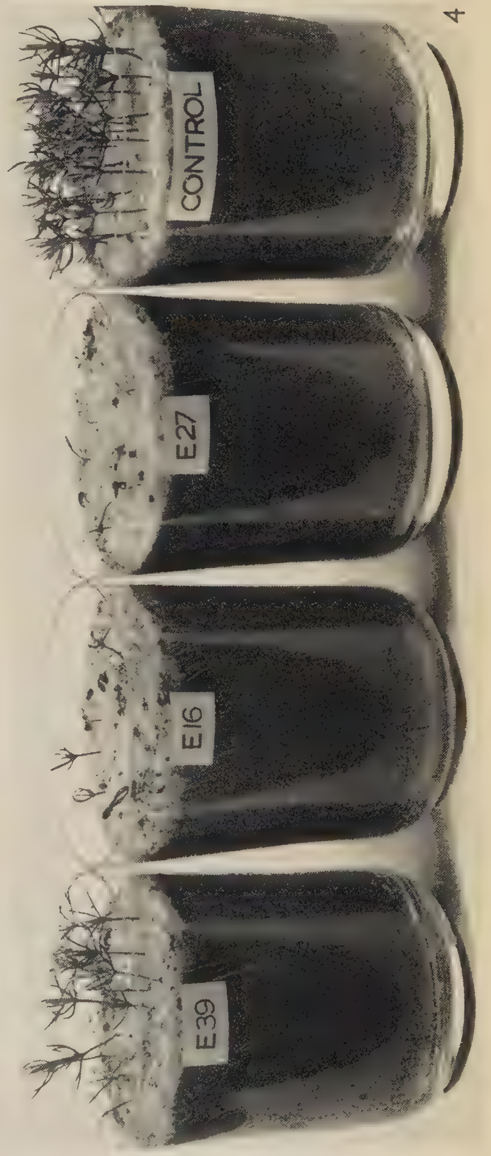
1



2



3



4

HUMICOLIN, AN ANTIFUNGAL SUBSTANCE PRODUCED BY *ASPERGILLUS HUMICOLA*

By P. J. CURTIS, H. G. HEMMING and E. G. JEFFERYS

Imperial Chemical Industries Ltd., Butterwick Research Laboratories, Welwyn, Herts

Aspergillus humicola Chaudhuri & Sachar produces a substance toxic to many fungi. In surface cultures the best titres have been obtained on nitrate-10 % glucose media. The active material is extracted from culture filtrates by charcoal, from which it is eluted with carbon tetrachloride. The petrol-ether soluble fraction of this eluate, a yellow oil, is named humicolin. It is a weakly acidic substance distilling at 210–215° C. at 10^{-2} mm. Hg. It can be crystallized at $-80°$ C. from methanol. It is moderately stable in aqueous solution at pH 3·5–4·5, but at higher pH is rapidly inactivated. Humicolin inhibits germination of *Botrytis allii* spores at 1 μg./ml.

The genus *Aspergillus* has been intensively investigated for the production of antibiotics. According to Gill-Carey (1949) only four species have not been tested—*A. delacroixii* (Sacc.) Thom & Church, *A. humicola* Chaudhuri & Sachar, *A. montevidensis* Talice & MacKinnon and *A. miyakoensis* Nakazawa, Simo & Watanabe. These are all little-known species. We have recently isolated, from limestone-cave soils in Great Britain, a form which appears to be *A. humicola.* It produces a highly antifungal substance in liquid culture which we propose to call humicolin.

THE MOULD

A. humicola was isolated on two occasions from a rather unusual habitat:

No. 385: from soil from Read's Cavern, Somerset; 17 January 1947. The organism was frequent in the sample.

No. 517: from soil (pH 7·7) from a deep cave at Ogof Ffynnon Ddu, Brecon; 17 May 1948. The organism was rare in the sample.

The two isolates appear to be identical. The growth characteristics of the mould at 25° C. on Czapek agar, steep agar and malt-extract agar (Raper & Thom, 1949) are:

Colonies, on Czapek agar rather restricted and thin, white at margin passing through shades of yellow to yellowish olive-green, velvety at the margin but loosely floccose at the centre, the reverse uncoloured or pale yellow. On steep agar similar but thicker and more floccose. On malt agar restricted and of closer texture than on Czapek agar, white at margin passing through a narrow zone of yellow to a bright green in the centre, of a darker shade than on Czapek agar, the reverse mainly uncoloured but with a dark greenish black centre.

Sporing heads, radiate. *Conidiophores*, 150–350 μ in length, if arising direct from the substratum; 30–100 μ, if borne on aerial hyphae; 4·5–5·5 μ in diameter, smooth walled and pale brown in colour. *Vesicles*, 10–14 μ in diameter, fertile area covering almost the whole surface in the larger heads, hemispherical in smaller heads. *Sterigmata*, primary 3·5–5·0 μ × 2 μ; secondary 3–4 μ × 2 μ. *Conidia*, globose or ovoid, 3–5 μ in diameter, usually smooth walled but occasionally finely granular.

This species does not fall unequivocally into any of the main groups of the genus *Aspergillus* but agrees quite well with *A. humicola* Chaudhuri & Sachar (1934). No. 385 has been examined by Dr K. B. Raper who confirmed that it corresponded reasonably well with this species. *A. humicola* appears to have been previously found only in India, at the time when it was first described, being isolated then from black-coloured soil taken from manure-pits.

RESULTS

Antagonism in agar culture

In the streak test (Brian & Hemming, 1947) *A. humicola* (both isolates) inhibited the fungus *Candida albicans* but not the following bacteria: *Staphylococcus aureus*, *Salmonella typhi*, *Bacterium coli*.

Culture on liquid media

'Glaxo' culture vessels and earthenware culture vessels were used as previously described (Brian, Curtis & Hemming, 1947). Antifungal activity was assayed by the *Botrytis allii* germination test, titres being expressed in arbitrary 'BA' units (Brian & Hemming, 1945) and as in work with other moulds (Brian *et al.* 1947) the nature of the nitrogen source was found to affect profoundly growth and antibiotic production: addition of organic acids also exerted a beneficial influence where inorganic ammonium compounds were used as nitrogen source. *Aspergillus humicola* was therefore grown on media in which these factors were varied (Table 1). In addition to the standard Czapek-Dox (CD) and Raulin-Thom (RT) media, containing nitrate and ammonia nitrogen, respectively, a set of simplified media, varying mainly in nitrogen source, were used: potassium nitrate (N), ammonium sulphate (AS), ammonium sulphate + 0·5 % malic acid (AS + M), ammonium tartrate (A). (For the detailed composition of these media, see Brian *et al.* 1947.) Two glucose levels, 5 and 10 % w/v, were used; all media were adjusted to pH 5·0 before autoclaving.

Growth was good on all media except AS. On changing from 5 to 10 % glucose, the final dry weight of mycelium was found to increase in all cases, but media yielding heavy growth at the low sugar level gave disproportionately larger increases of dry weight at the high sugar level. For example, yields with 5 and 10 % glucose for medium AS were 1·08 and 1·20 g. respectively, a change of 11 %, but for Czapek-Dox they were 2·37 and 3·40 g., a change of 44 %.

On the unsupplemented ammonium sulphate medium titres were low at both sugar concentrations, all activity having disappeared after 14 days. On the other ammonia nitrogen media (RT, A and AS + M) high titres developed in 14 days, thereafter remaining fairly steady. Rather higher titres were obtained on the 5 % glucose medium than on the 10 % glucose medium. On the nitrate media with 5 % glucose high titres were obtained early in the fermentation (7 days), but activity declined rapidly after 14 days. With 10 % glucose there was no decline in activity and titres continued to rise until the end of the experiment (21 days). Highest titres were obtained on these media. Examination of the pH data suggests that drift to a high pH (low sugar nitrate media) or to a very low pH (AS, both sugar levels) may cause loss in activity.

Table 1. *Development of fungistatic activity, pH drift and final dry weight of cultures of* Aspergillus humicola *on liquid media*

		Activity (BA units/ml.)						
Glucose (%)	Medium	4 days	7 days	10 days	14 days	18 days	21 days	Mean dry wt. of mycelium (g./vessel)
5	CD	—	32	32	48	16	8	2·37
	N	—	48	48	64	—	—	2·35
	AS	—	16	8	8	—	—	1·08
	AS+M	—	8	8	16	16	48	1·77
	RT	—	2	12	48	32	48	2·17
	A	—	2	6	48	128	96	1·72
10	CD	—	24	64	128	128	768	3·40
	N	—	48	64	96	96	192	3·20
	AS	—	16	12	8	—	—	1·20
	AS+M	—	16	12	24	8	16	1·97
	RT	—	1	4	24	8	16	3·18
	A	—	16	16	32	32	48	2·23

		pH						
Glucose (%)	Medium	0 day	4 days	7 days	10 days	14 days	18 days	21 days
5	CD	4·6	5·7	7·6	7·7	7·6	7·6	7·8
	N	4·9	6·8	7·5	7·7	7·8	7·2	8·2
	AS	4·7	2·7	2·4	2·3	2·3	2·2	2·1
	AS+M	5·2	5·1	4·6	4·6	4·7	4·6	4·4
	RT	4·9	4·5	3·8	3·6	3·5	3·4	3·5
	A	5·0	4·3	3·4	2·9	2·9	2·6	2·5
10	CD	4·6	6·3	6·8	7·2	7·4	7·2	7·5
	N	4·8	6·1	6·9	7·4	7·5	7·3	7·0
	AS	4·6	3·0	2·3	2·2	2·3	2·2	2·1
	AS+M	5·2	5·0	4·6	4·6	4·7	4·7	4·4
	RT	5·1	4·5	3·6	3·2	3·2	2·8	2·6
	A	4·5	4·3	2·8	2·8	2·7	2·4	2·3

Extraction of humicolin

The activity was removed from culture filtrates by extraction with chloroform, benzene, carbon tetrachloride and petrol ether between pH 3·5 and 9·0. It was also removed by B.D.H. activated charcoal (1 g./l.), and active material was eluted from the charcoal with most organic solvents.

Batches of *A. humicola* culture filtrates, from cultures grown for 10 days on Czapek-Dox (10 % glucose) giving assays of 32–128 BA units/ml. were treated with charcoal. This was eluted with carbon tetrachloride in a universal extractor (Brian *et al.* 1947). Carbon tetrachloride was more rapid in action than petrol ether but, like petrol ether and unlike other solvents, it did not elute much pigmented material. The eluates were evaporated to dryness and the residues treated with cold petrol ether, which dissolved the antibiotic, leaving a nearly inactive residue. The oil, humicolin, which was obtained by evaporating these solutions, inhibited germination of *Botrytis allii* spores at 1 μg./ml.

Properties of humicolin

Humicolin may be distilled at 210–215° C. at 10^{-2} mm. Hg pressure. On cooling to $-80°$ C. with solid carbon dioxide it crystallized from methanol and sometimes from acetone. The oil contains no nitrogen, sulphur or halogen. It is extracted from petrol ether solution by sodium carbonate solution, but not by a buffer at pH 9·0; this indicates the presence of a phenolic or enolic group. In sodium carbonate solution it is rapidly inactivated by ultra-violet light. An alcoholic solution gives a brown colour with ferric chloride.

Stability of humicolin

Solutions in germination medium (Brian & Hemming, 1945), ranging from pH 3·5 to 7·5, were kept at 25° C. and assayed after 24 hr. All activity was lost at pH 7·0 and above, 50 % at pH 5·4 and only 25 % at pH 3·5 and 4·5. Humicolin resembles a number of other antifungal substances of fungal origin—viridin, gliotoxin, frequentin and albidin—in being relatively stable at low pH but fairly unstable at pH 7 or above. It is not inactivated at pH 3·5 by cysteine.

Biological activity of humicolin

The minimum concentration required to inhibit germination of the spores of a number of different fungi (Table 2) ranged from 0·4 to 12·5 μg./ml. with one exception, *Absidia glauca*, germination of which was not prevented by 50 μg./ml.

Table 2. *Fungistatic activity of humicolin*

Test fungus	Least concentration (μg./ml.) inhibiting germination
Absidia glauca Hagem (464)	> 50·0
Aspergillus niger v. Tiegh. (32)	6·2
A. terreus Thom (274)	0·8
Botrytis allii Munn. (38)	1·2
Fusarium coeruleum (Lib.) Sacc. (35)	0·4
Mucor mucedo Bref. (322)	3·1
Myrothecium verrucaria (Alb. & Schw.) Ditm. (173)	3·1
Penicillium expansum Link (57)	6·2
P. gladioli McCull. & Thom (59)	3·1
Stemphylium sp. (134)	3·1
Thamnidium elegans Link (321)	6·2
Trichoderma viride Pers. ex Fries (211)	12·5

Note. The numbers given in parentheses are the accession numbers of the fungi in the Butterwick culture collection.

At pH 5·0, 8 μg./ml. in broth humicolin completely inhibited *Bacterium globiforme*, partially inhibited *Bacillus subtilis* and *Staphylococcus aureus* but did not inhibit *Bact. coli*. Higher concentrations were not tested.

We wish to thank Dr P. W. Brian for valuable advice. We are also indebted to Mr I. S. Nixon for collecting the soil samples, and to Mr W. K. Smith for antibacterial data.

REFERENCES

BRIAN, P. W., CURTIS, P. J. & HEMMING, H. G. (1947). Glutinosin: a fungistatic metabolic product of the mould *Metarrhizium glutinosum* S. Pope. *Proc. roy. Soc.* B, **135**, 106–132.

BRIAN, P. W. & HEMMING, H. G. (1945). Gliotoxin: a fungistatic metabolic product of *Trichoderma viride. Ann. appl. Biol.* **32**, 214–220.

BRIAN, P. W. & HEMMING, H. G. (1947). Production of antifungal and antibacterial substances by fungi: preliminary examination of 166 strains of Fungi Imperfecti. *J. gen. Microbiol.* **1**, 158–167.

CHAUDHURI, H. & SACHAR, G. S. (1934). A study of the fungus flora of Punjab soils. *Ann. mycol., Berl.*, **32**, 90–100.

GILL-CAREY, D. (1949). Antibiotics from Aspergilli. *Brit. J. exp. Path.* **30**, 114–118.

RAPER, K. B. & THOM, C. (1949). *A Manual of the Penicillia.* London.

(*Accepted for publication* 8 *January* 1952)

AQUATIC ASCOMYCETES: *LORAMYCES JUNCICOLA* WESTON AND *L. MACROSPORA* N.SP.

By C. T. INGOLD and B. CHAPMAN
Birkbeck College, University of London

(With Plate 12 and 3 Text-figures)

Loramyces juncicola Weston and *L. macrospora* n.sp., both submerged aquatic saprophytes on reed-swamp plants, are described from the English Lake District, and the differences between the two species are indicated. The growth of *L. juncicola* in pure culture is reported.

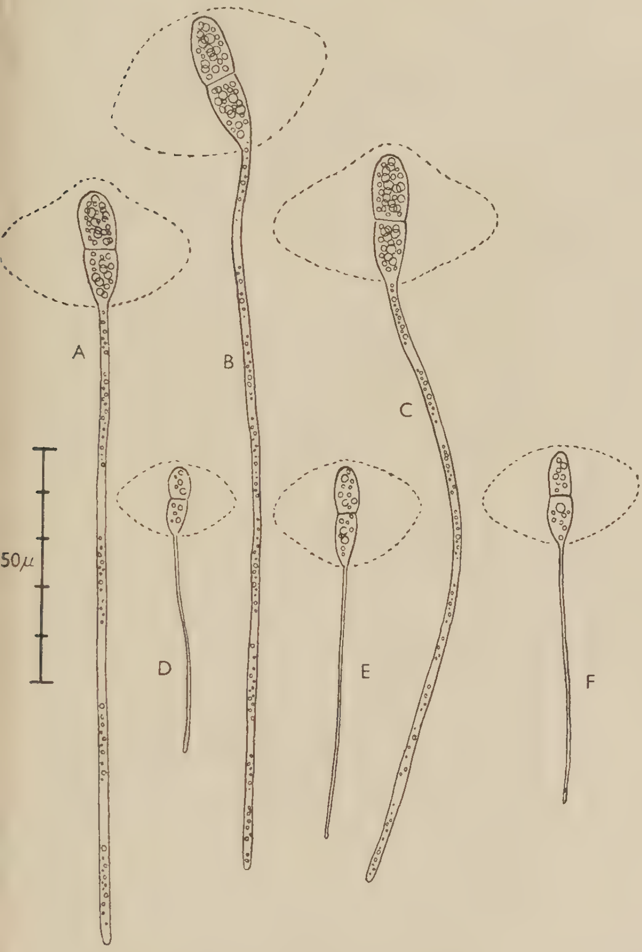
The genus *Loramyces* was erected by Weston (1929) on the basis of a single species, *L. juncicola*, growing as a saprophyte on submerged stalks of *Juncus militaris* in ponds on islands off the coast of Massachusetts, U.S.A. Since then no further species appear to have been described nor are there references to the type-species having been found in other localities.

During the past two years one of us (C.T.I.) has become interested in the rich flora of aquatic Ascomycetes growing on submerged parts of dead reed-swamp plants and on submerged water-logged twigs and branches. In the course of an investigation of these fungi in the English Lake District two species of *Loramyces* have been noted. The one most commonly encountered agrees in all essential features with the type species, the other is believed to be undescribed.

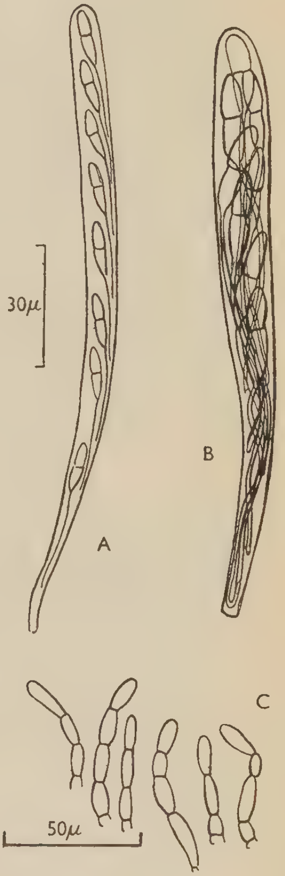
Loramyces juncicola Weston

Loramyces juncicola was found in Windermere (June 1951) growing on submerged dead, but still attached, stalks of *Scirpus lacustris*, in Little Langdale Tarn (August 1951), on *S. lacustris* and also very occasionally on *Equisetum limosum*, and in Blea Tarn (August 1951) in great abundance on submerged dead stalks of *Eleocharis palustris* and *Juncus articulatus*.

Weston gave a full and well-illustrated account of *Loramyces juncicola* so that comparison of the Lake District specimens with the original description is easy. In both the American and British specimens the perithecium is broader than high and is seated on a small subicle. Weston gives the usual diameter of the perithecia as 0·5–2·0 mm., but in the Lake District material the diameter seldom exceeds 0·5 mm. The perithecium, particularly towards the ostiole, is clothed with hairs. In the British material each of these consists of a chain of a few cells (Text-fig. 2, C). In Weston's account hairs are figured only in a vertical section of a perithecium at rather a low magnification and would seem to be shown in a somewhat diagrammatic way. They appear from this figure to be unicellular. Within the perithecium in the British, as in the American material, very numerous asci are to be seen in a mature specimen intermixed with numerous narrow simple paraphyses. The spores are colourless, 2-celled and, without their tails, are from 15 to 20 μ in length and 5 to 6 μ in breadth. These measurements agree very well with those of Weston. In the ascus the spores form a single series and the long narrow tails (av. 52 μ × < 1·0 μ), which are mostly quite straight, lie neatly along one side of the ascus. When a ripe perithecium is crushed in water, spore discharge at once occurs from all the fully developed asci. The ascospores escape in succession through a terminal pore as Weston has described. When liberated spores are mounted in indian ink, a mucilaginous capsule is visible around the 'head'



Text-fig. 1.



Text-fig 2.

Text-fig. 1. Ascospores: A, B, C, spores of *Loramyces macrospora* and D, E, F of *L. juncicola*. All drawn to same scale with camera lucida from living material. Outline of mucilage capsule around 'head' of each spore shown by dotted line.

Text-fig. 2. A, ascus of *Loramyces juncicola*; B, ascus of *L. macrospora*; C, hairs from surface of perithecium of *L. juncicola*. Drawn from pickled material.

of each. In the Lake District material this capsule is wider than that shown by Weston.

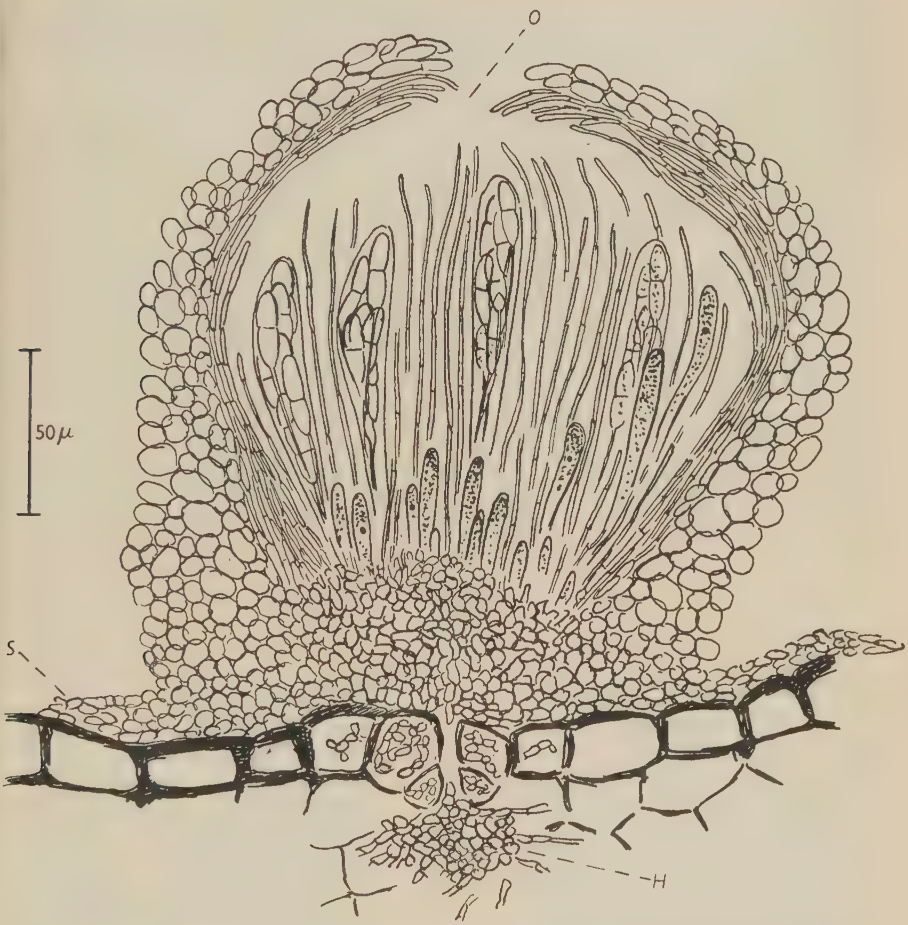
Weston did not grow the fungus in culture, but followed growth from spores in hanging-drops for a week or two and noted that no accessory asexual spores were produced. From the British material a number of single-spore pure cultures were made. The fungus grew well on 2 % malt agar, the mycelium being for the most part colourless and within the medium with relatively little white aerial growth. In some old cultures a few blackish dots appeared which on examination proved to be aggregates of dark-coloured cells and are, perhaps, to be regarded as sclerotia. No conidial stage was produced on agar, nor when strips of a colony were submerged in water. Further, on agar no perithecia were formed. An attempt was then made to induce their formation by growth on a natural substratum. Pieces of the stem of *Eleocharis palustris*, sterilized in the autoclave, were submerged in flasks of sterile water and inoculated with the mycelium from tube cultures on malt agar. The flasks were left exposed to light in the laboratory. After two months perithecia developed on the surface of the *Eleocharis* stems. They resembled those found in the Lake District, but were quite white in contrast to those found in nature which are usually dark and often nearly black, although occasionally some are found that are nearly white. Since perithecia originated from single-spore cultures, the fungus is clearly homothallic.

Loramyces macrospora sp.nov.

Fungus aquaticus. Perithecium minutum, 120–230 μ × 180–260 μ, superficie nullis pilis obsita, parvo subiculo nixum. Ascus clavatus, 14 μ × 150 μ, continens 8 ascosporas subdistichas, hyalinas; ascosporae singulae longae 22–30 μ, latae 7–8 μ (excepta cauda) in duabus cellulis consistunt, quarum inferior promittit caudam 100–140 μ × 2·5 μ, plenam protoplasmatis guttulas minutas oleosas continentis. Paraphyses plurimae, filiformes, simplices.

Hab. in ramulis mortuis Equisaeti limosi, Little Langdale Tarn, Angliae.

This species occurred on dead internodes of *Equisetum limosum* forming the upper parts of submerged truncated stalks of which the lower internodes were still alive. It was found in August 1951 near the outflow end of Little Langdale Tarn and, even when the water-level was at its lowest, the fungus was well below the surface. Because of the character of its spores (Text-fig. 1) this species clearly belongs to *Loramyces*, but it differs sharply from *L. juncicola* in a number of characters. The spores are much larger, the 'head' being 22–30 μ × 7–8 μ and the 'tail' 100–140 μ × 2·5 μ. Further, the lumen of the 'tail' is normally slightly more than 2·0 μ wide and contains numerous oil drops, whilst in the ascospore of *L. juncicola* the lumen is less than 1 μ wide and the protoplasm appears homogeneous. So narrow is the lumen of the tail in the type species that it is difficult to show it in a high-power drawing without exaggerating its width. Although the ascus is about the same length in the two species, that of *L. macrospora* is broader and the spores have a roughly biseriate arrangement (Text-fig. 2, B). Further, because the tails of the spores are so long they cannot lie straight and neatly arranged as in the ascus of *L. juncicola*. In consequence, the bottom part of the ascus in *L. macrospora* is occupied by a twisted sheaf of tails some of which are bent back on themselves. The tails, however, do not become seriously entangled, since when the ascus ruptures the spores escape singly through an apical pore as in the type species. Also, as in *L. juncicola*, the liberated spore is surrounded by a mucilaginous capsule.



Text-fig. 3. *Loramyces macrospora.* Longitudinal section: perithecium on dead *Equisetum limosum*. *O*, ostiole; *S*, subicle; *H*, substomal hyphal-knot.

Another feature distinguishing *L. macrospora* is the small size of the perithecium and its shape (Text-fig. 3). Measurements of 16 sectioned perithecia ranged from 120 to 225 μ in breadth and 180 to 260 μ in height (av. 180 μ × 215 μ). In *L. juncicola* the average dimensions of 7 sectioned perithecia were 455 × 285 μ. Thus in *L. juncicola* the perithecium is much broader than high, whilst in *L. macrospora* it is usually slightly higher than broad (Pl. 12). In *L. macrospora* there are normally less than fifty ripe or nearly ripe asci in a mature perithecium, but in *L. juncicola* there are usually several hundred.

The perithecium of *L. macrospora* is seated on a subicle and is apparently always situated above a stoma, below which is a little parenchymatous knot of fungal tissue.

The type specimen of *L. macrospora* has been deposited at the Commonwealth Mycological Institute, Kew (Herb.I.M.I. 48630).

Our best thanks are due to Mr D. Jones for his help with the Latin diagnosis.

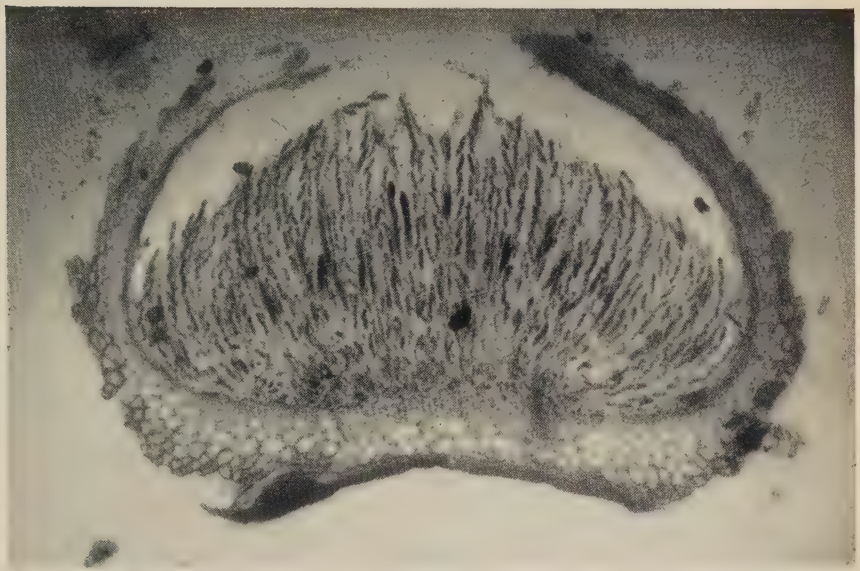
REFERENCE

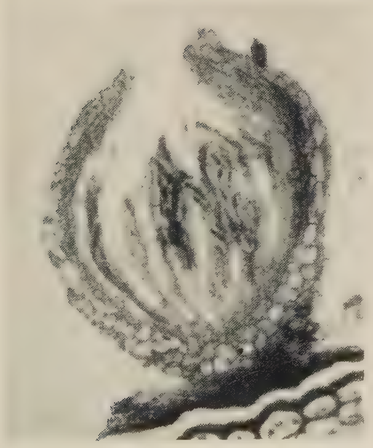
WESTON, W. H. (1929). Observations on *Loramyces*, an undescribed aquatic Ascomycete. *Mycologia*, **21**, 55–76.

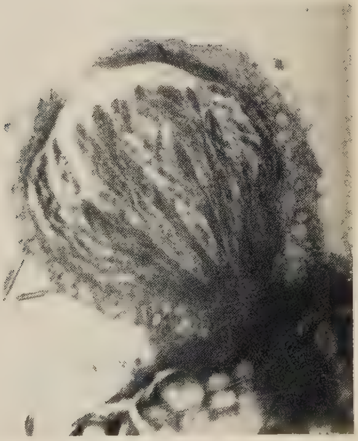
EXPLANATION OF PLATE 12

Median sections of perithecia. Above, *Loramyces juncicola* separated from its substratum. Below, two specimens of *L. macrospora* on *Equisetum limosum*. All ×205.

(*Accepted for publication* 19 *January* 1952)







THREE MOULDS FROM DAMP WALLS

By FRANCES L. BALFOUR-BROWNE
British Museum (Natural History)

(With 2 Text-figures)

Extensive mycelial mats, formed on plaster on the inside walls of a London house, consisted of a mixture of three hyphomycetes: *Rhinotrichum domesticum* n.sp., *R. lanosum* Cooke, and *Sepedonium albo-griseum* n.sp. The third species is heterogenous and includes black and white forms.

The fungal growth here described was found by Dr H. E. Hinton, until recently on the staff of the British Museum (Natural History), while searching for mould-feeding beetles in a London house. It had formed fawn-coloured woolly mats on several inside walls and extended over half the ceiling in one room. A water pipe had burst at the top of the house with consequent dampness of the plaster. The tenant observed the fungus n the following month. The previous winter there had also been a burst, but fungal development had been slight.

Superficially the growth appeared to consist of a single organism. Microscopical examination, however, showed the presence of three distinct hyphomycetous fungi which were completely intermingled: *Rhinotrichum lanosum* Cooke, a species of *Rhinotrichum* not previously described and another mould, also new to science, which is assigned to *Sepedonium*.

The mycelium of the *Rhinotrichum* species in the original mat consisted of creeping, branched, septate hyphae bearing spicules from which conidia had become detached. Conidia arose on any part of the mycelium, but generally they were borne on more or less sharply differentiated conidiophores arising as short branches at right angles to the parent hyphae. The conidia were of two kinds, approximately 8–10 × 4–6 μ and smooth or 20–35 × 15 μ and spiny, the two forms never arising from the same hypha. Scores of cultures were made from single conidia of as many different izes as possible, varying on the two basic sizes. But only two kinds of culture were obtained: a light fawn, velvety growth with small, smooth-walled conidia, averaging 9 × 5 μ, and a dark fawn to light brown woolly eries of cultures with large, echinulate conidia, varying from 20 to 35 μ in length.

A large number of single spore isolations were made from each type of ulture and repeatedly from their progeny and a growth form constant to ach always resulted, no intermediate forms or mixed colonies being btained. It is assumed, therefore, that two distinct fungi are represented: small-spored form, which is identical with *Rhinotrichum lanosum* Cooke, nd a large-spored fungus which could not be identified with any described species and is here named *R. domesticum.* Deliberate mixing of the two fungi did not give rise to intermediate forms.

The presence of two congeneric species, completely intermingled, occupying the same substratum provokes speculation as to their origin and occurrence in this situation. The differences between them would appear to be too marked for one to be a simple mutant or a giant form of the other. That a heterokaryotic species (i.e. a species having a mixed population of nuclei within the same cytoplasm) is represented is also ruled out as only two entirely distinct and constant forms are present, no mixed or intermediate cultures being obtained as would be expected had some developed from a conidium or hypha having two, or more, genetically different nuclei. It must be assumed then that the organisms are distinct, perhaps not even closely related and that they occupy the same site as fortuitously as does the *Sepedonium* which formed the third component of the original growth.

Rhinotrichum domesticum Balfour-Browne sp.nov.

Mycelium lanosum, late effusum, ochraceo-brunneum, in 'agar' caespitulis formans; hyphae hyalinae, adscendentes et repentes, septatae, vage ramosae, 5–7 μ latae; conidiophorae ± distinctae; conidia subglobosa vel pyriforma, echinulata, ochracea, 16–35 × 11–24 μ, ex apice sterigmatatum orientes.

Habitat. In charta uda et in tectorio murali, London, 5 November 1941; Dr H. E. Hinton legit. Typus in Herb. Mus. Brit.

Mycelium fawn to brown, spreading, woolly; hyphae hyaline, creeping and ascending, branching, septate, 5–7 μ wide; conidiophores ± distinct, formed of short branches perpendicular to the parent hyphae, denticulate; conidia subglobose or pyriforme, echinulate, ochraceous, 16–35 × 11–24 μ, borne on sterigmata.

Habitat. On damp paper and plaster of walls, London, 5 November 1941; leg. Dr H. E. Hinton. Type (F.L.B. 100) in Herb. Mus. Brit.

R. domesticum produces a light brown woolly growth on various media: Sabouraud's glucose, potato dextrose, beef extract and a medium containing added lime. The conidia varied from subglobose or oval and averaging 25 × 12 μ, to pear-shaped or fusiform. Generally the subglobose predominated but occasionally in some cultures, for no known reason, the pyriform were more abundant and reached as much as 35 μ in length. Single spore cultures from such large conidia, however, gave rise to growths similar to those from conidia of average size and usually bore average sized conidia.

Here and there in old cultures clumped masses of interwoven hyphae would form soft cushion-like bodies.

Rhinotrichum lanosum (Cooke) Cooke

Clinotrichum lanosum Cooke, *Pop. Sci. Rev.* **10**, pl. 68, figs. 1–3, 1871.
Rhinotrichum lanosum Cooke, *Handbk Br. Fungi*, **2**, 591, 1871.
R. parietinum Sacc., *Atti Accad. sci. ven.-trent.-istr.* ser. 2, **2**, 478, 1896
Bull. Soc. mycol. Fr. **12**, 79, pl. 7, fig. 2, 1896.

In the original account of his fungus M. C. Cooke proposed the genus *Clinotrichum* for it, while stating that it was a *Rhinotrichum.* A little later in he same year he included it in his *Handbook of British Fungi* under the atter genus.

Cooke's description of the fungus does not give spore measurements, nd his figures show regularly alternating short basidium-like branches earing terminally two to four sterigmatoid processes supporting the onidia. Examination of his original material, kindly lent by the uthorities of the Royal Botanic Gardens, Kew, shows that although this ype of conidiophore occurs, conidia are also borne along the whole length f the lateral hyphae and occasionally also on the main hyphae. In 1896, . A. Saccardo described *R. parietinum* from damp plaster walls from a hotouse of the Botanic Gardens, Padua. A good diagnosis and figure indicate

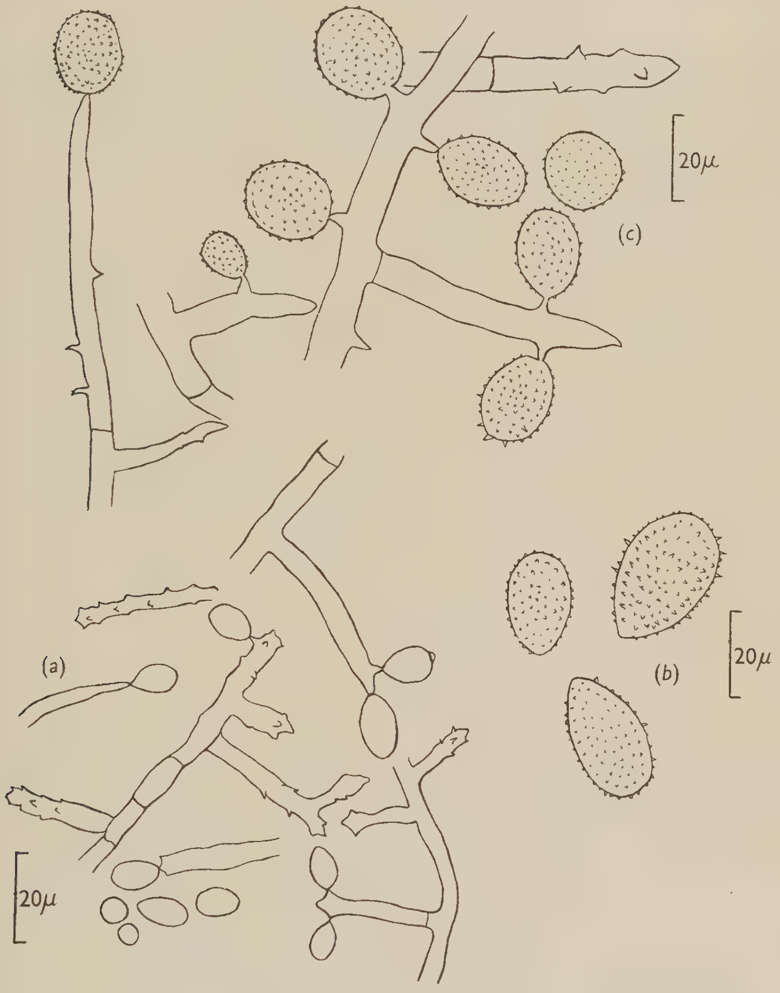


Fig. 1. (*a*) *Rhinotrichum lanosum* Cke; (*b*) *R. domesticum* n.sp., large pyriform conidia; (*c*) *R. domesticum* n.sp., subglobose conidia.

that this species is identical with *R. lanosum*. Apart from the collections already mentioned, the fungus has been recorded from Saltaire, Yorkshire (Massee & Crossland, 1905) and was found by Miss E. M. Wakefield (Massee, 1911).

Sepedonium albo-griseum Balfour-Browne sp.nov.

Fungus mycelio effuso, arachnoideo vel sericeo. Duas formas demonstrans: formam albidam et formam fuscam. Forma albida: hyphis hyalinis, flexuis, levibus, septatis, ramosis; ramulis fertilis, brevibus, racemosis vel botryosis, raro solitariis; chlamydosporis hyalinis, levibus, globosis, 18–26 μ dia.; episporis 3 μ latis. Forma fusca: ex forma hyalina obtegens, hyphis fusco-brunneis, irregulariter papillatis vel squamas minutas vel magnas gerentibus; chlamydosporis raris, globosis, brunneis, levibus, 18–26 μ dia.; episporis 3 μ latis.

Habitat. In charta uda et in tectorio murali. London, 5 November 1941; Dr H. E. Hinton legit. Typus in Herb. Mus. Brit.

Fungus with spreading, fluffy or velvety mycelium, exhibiting two forms: a white form and a blackish form. White form: with hyaline, flexuous, smooth, septate, branching hyphae; fertile branchlets short, racemose or botryose, rarely solitary; chlamydospores hyaline, smooth, globose, 18–26 μ diameter; epispore 3 μ wide. Blackish form: hyphae fuscous, irregularly papillate or bearing large or small scales; chlamydospores rare, globose, brown, smooth, 18–26 μ diameter; epispore 3 μ wide.

Habitat. On damp plaster and paper of walls, London, 5 November 1941; leg. Dr H. E. Hinton. Type (F.L.B. 101) in Herb. Mus. Brit.

In the original mat of fungi the *Sepedonium* was not distinguishable macroscopically from the *Rhinotrichum* species with which it was intermingled, but in artificial cultures containing all three fungi it was recognizable as a whitish fluffy growth which gradually spread over the fawn *Rhinotrichum*. Microscopical examination of the *Sepedonium* from the original material and from monosporous cultures grown on a number of different media, showed hyaline mycelium and chlamydospores and in the older cultures there were generally present dark brown or blackish hyphae and chlamydospores. These dark-coloured hyphae (brown under the microscope and black to the naked eye), are relatively stiff and set with protuberances varying from small knobs to cup-like scales. The hyaline hyphae are more flexible and have a smooth surface. The chlamydospores, whether white or dark, are similar in size and shape, the former are, however, very abundant and the latter very infrequent.

Large numbers of single spore cultures were made in an attempt to separate the dark and light forms. Mostly the colonies are white, and during the second and third week begin to change to grey and black. Occasionally, however, from morphologically quite similar spores, a permanently white growth was obtained, less fluffy and more compact, bearing abundant chlamydospores. This remained constant after many subcultures. It has, however, not been possible to separate the dark form in a pure state; the fuscus chlamydospores are rare and when found difficult to detach, and hyphae, when isolated and placed on fresh media, have so far failed to continue growth.

The darkening of the majority of the cultures was not due to a gradual darkening of hyphae which were originally white but apparently to a late growth of dark mycelium, originating from, and growing over, the white. The dark hyphae generally appeared at random throughout the colony and never formed sharply defined sectors, although sometimes the dark growth was confined to one area or patch.

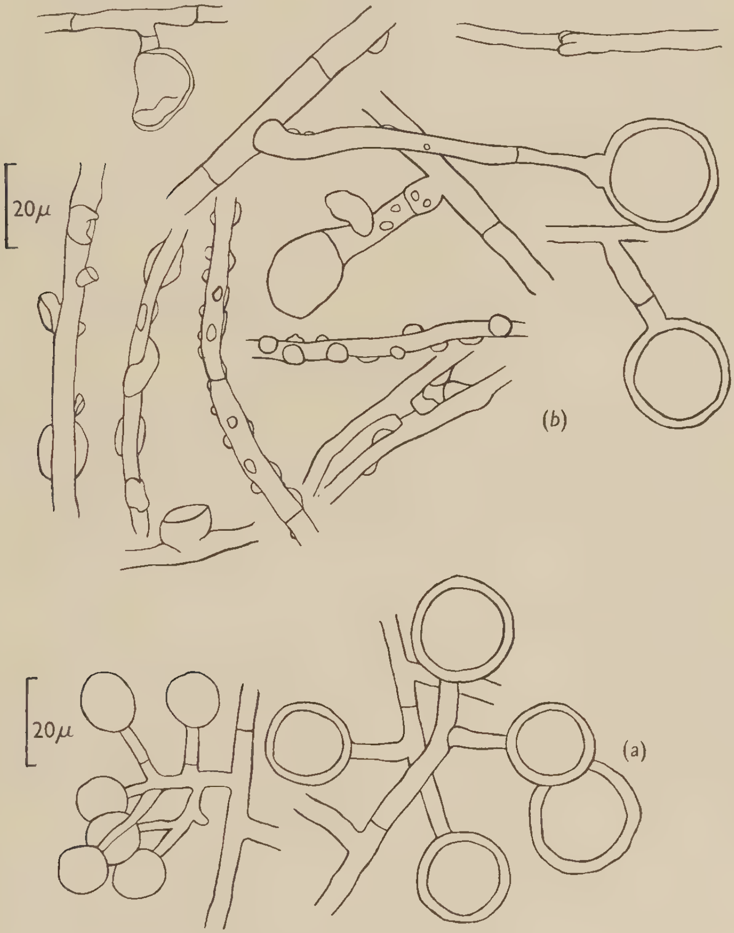


Fig. 2. *Sepedonium albo-griseum* n.sp.: (*a*) white form; (*b*) blackish form.

The *Sepedonium* is thus seen to be heterogenous, consisting of a complex of black and white forms. The change from the white to the black state s not obviously related to a change in the constitution of the medium, such as staling might cause, as some of the colonies remain permanently white. Nor, without labouring it, are there sufficient data to warrant an attempt to explain the origin of the dark and light forms either on mutational or heterokaryotic lines. The nuclei are very small and no structural differences were seen. Hyphal anastomoses were frequent in both forms.

REFERENCES

Cooke, M. C. (1871). *Pop. Sci. Rev.* (reprint), **10**, pl. 68, figs. 1–3.
Cooke, M. C. (1871). *Handbook of British Fungi*, **2**, 591, fig. 263.
Massee, G. (1911). Fungi; 4th series. *Kew Bull.* no. 9, 377.
Massee, G. & Crossland, C. (1905). *The Fungus Flora of Yorkshire*, p. 331.
Saccardo, P. A. (1896). Le piante spontanee nel regio orto botanico di Padova. *Atti Accad. sci. ven.-trent.-istr.* 2 ser., **2**, 478.
Saccardo, P. A. (1896). Notes Mycologiques. *Bull. Soc. mycol. Fr.* **12**, 79–80, pl. 7, fig. 2.

(*Accepted for publication* 25 *January* 1952)

HYPOGEOUS FUNGI. II AND III

By LILIAN E. HAWKER
Department of Botany, University of Bristol

(With 2 Text-figures)

Hydnangium carneum Wallr. var. *xanthosporum* var.nov. from North Wales differs from the type by its less brightly coloured fruit-body and by the yellow-brown pigmentation of its spores.

Gautieria morchellaeformis Vitt. from Gloucestershire, *Hymenogaster hessei* Soehner from Gloucestershire, Somerset and other areas, and *Elaphomyces aculeatus* Vitt. from Gloucestershire, are new records for Britain.

II. A NEW VARIETY OF *HYDNANGIUM CARNEUM* WALLR. FROM NORTH WALES

Among hypogeous fungi collected during the Autumn Foray of the Society, held at Bangor in September 1950 (Smith, 1951), were several collections of a species of *Hydnangium* which did not agree exactly with any published description. Three large collections (H251, 255, 257*) were made on 13 September 1950 in spruce plantations near Bettws-y-Coed. An immature specimen (H247) was found on the same day in another part of the plantations and another (H236) was found on the previous day at Vaynol Park, Bangor.

The fruit-bodies were just beneath the surface of the needle cover. No obvious mycelia or rhizomorphs were present in the surrounding litter or the underlying soil. The specimens varied from 1 to 18 mm. (av. 10 mm.) in diameter. They were spherical or ovoid, sometimes slightly wrinkled and had a definite hollow or cavity at the base (Fig. 1 A, B).

The peridium was smooth, with a slight 'bloom' on the surface, and was cream in young specimens but later, or when bruised, becoming flesh-coloured, dull reddish and finally dark brown. It was very thin (*c.* 50 μ thick), and in large mature specimens was obviously stretched tightly but did not tear to expose the gleba. It consisted of slender hyphae (1·5–2 μ diameter), which were in general interwoven to form a tough elastic layer parallel to the surface of the fruit-body, but many turned outwards to end in a short, slightly swollen cell projecting beyond the surface and collectively giving the 'bloom' mentioned above (Fig. 1 C).

There was no sterile base or columella in even the youngest specimen available. The gleba was at first white and later brown. The cavities were formed at an early stage and were well developed in fruit-bodies of only a millimetre in diameter. In mature fruit-bodies they were large and convoluted (Fig. 1 D). The dissepiments were very thin. The tramal layer was seldom more than 20 μ thick and consisted of slender hyphae (*c.* 2 μ

---

* The numbers are those of my collection of hypogeous fungi. Specimens of most of those described have been deposited at the Herbarium, Royal Botanic Gardens, Kew.

diameter) interwoven with a few larger elements some of which contained latex. These were too few to cause a visible exudation of latex when the fruit-bodies were cut. In mature fruit-bodies the slender elements of the trama tended to disintegrate (Fig. 1 D, E) leading to a splitting of the dissepiment so that the chambers became separate and the gleba had a crumb-like structure. In very old specimens these chambers, enclosed

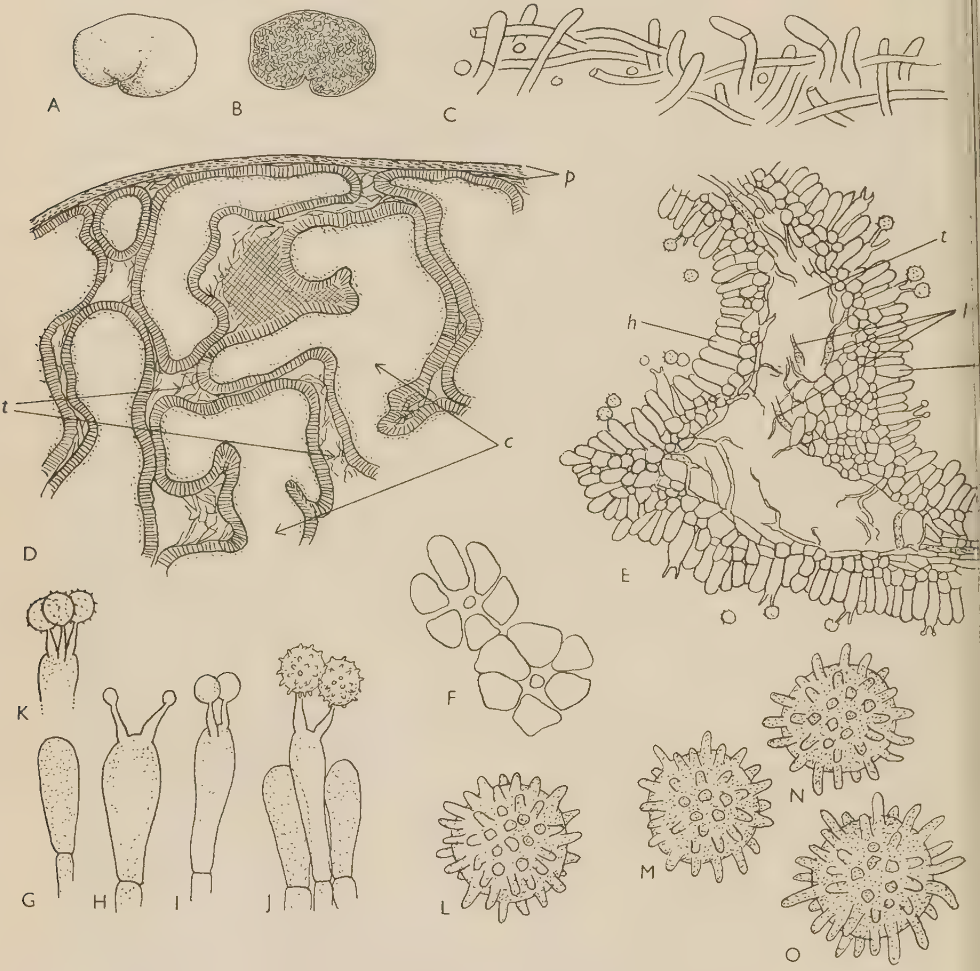


Fig. 1. *Hydnangium carneum* Wallr. var. *xanthosporum* Hawker. A, fruit-body, external view, natural size. B, fruit-body cut longitudinally, natural size. C, hyphae from outer peridium showing projecting ends of hyphae which give a felted appearance to fruit-body. (× 500.) D, peridium (*p*) and part of gleba. Note convoluted chambers (*c*) and splitting of trama (*t*). (× 30.) E, hymenium (*h*) showing young and mature basidia and trama (*t*) showing disintegration of central hyphae leading to longitudinal splitting of dissepiment. Note occasional latex vessels (*l*). (× 150.) F, clusters of cells, as seen in tangential section of inner peridium, resembling sphaerocysts of species of *Russula* and *Lactarius*. (× 550.) G–J, stages in development of basidia. (× 550.) K, 3-spored basidium. (× 550.) L–O, mature spores. (× 1300.)

in the hymenium, were thus actually minute peridiola of simple structure. Elements similar to those of the trama also occurred between the peridium and the hymenial layers of the outermost chambers. Tangential sections of this region showed an occasional grouping of the larger elements in rosettes (Fig. 1 F), resembling the sphaerocysts of species of *Lactarius* and *Russula*.

The hymenium and subhymenium formed a compact and regular layer lining each glebal chamber and remained intact even when the trama had split apart. This relative toughness of the hymenial layer may in part account for the tearing of the trama in which a state of tension is no doubt set up by the lateral expansion of the hymenium. The subhymenial layer consisted of thin-walled hyphae varying from 1·4 to 3·5 μ in diameter. The hymenium of mature specimens was a homogeneous layer of clavate basidia in all stages of development (Fig. 1 G–K) each of which arose from a definite stalk cell. Only a small proportion of the basidia bore ripe spores at one time. Mature basidia were of average size 34 × 11·5 μ and tapered slightly to the base. The majority were either immature or, in old specimens, collapsed. Most basidia bore two spores on long slender sterigmata (*c.* 8 μ long), but occasionally 1-spored and rarely 3-spored basidia were present (Fig. 1 K).

The spores were at first colourless and smooth, but when mature (Fig. 1 L–O) were pale yellow-brown, spherical (10–14·5 μ (av. 11·5 μ), excluding spines) and with blunt spines (*c.* 3 μ long) which were of an amyloid nature since they stained black with Melzer's solution.

Except for the colour of the fruit-body and the pigmentation of the spores the characters of these specimens closely resemble those of *Hydnangium carneum* Wallr. Spore size (excluding spines) of this species given by Hesse (1891), Massee (1889) and Dodge and Zeller (1936) are 12–14, 12 and 10 μ, respectively. These authors and Bataille (1923) agree that the spores of *H. carneum* are colourless. Cunningham (1944) describes the spores of material from New Zealand as 'globose, 14–18 μ diameter (including spines), epispore highly refractive, feruginous or tinted only, 2 μ thick, covered with coarse echinulate spines which are broad at the base, regular, hyaline and 2–2·5 μ long'. Cunningham's material differed from both the type and the present collections in the presence of a sterile base and a dendroid columella. These differences might be thought to warrant the removal of the New Zealand material from *H. carneum*. Since the Welsh material does not differ so markedly from the type it is proposed to include it as:

Hydnangium carneum Wallr. var. **xanthosporum** var.nov.

A typo differt fructificationis colore cremeo, dein rubescente, dernum obscure brunneo, et sporis intus flavobrunneis.

Inter acubus emortius Piceae, Bettws-y-Coed, North Wales.

Differs from type in colour of fruit-body, cream, becoming flesh-coloured and finally dark brown, and in yellow-brown pigment in spores.

In needle litter under spruce, Bettws-y-Coed and Vaynol Park, North Wales. Type collection 13 September 1951 (H251). Material deposited in Herbarium of Royal Botanic Gardens, Kew, and in Department of Botany, University of Bristol.

III. THREE NEW BRITISH RECORDS: *GAUTIERIA MORCHELLAEFORMIS* VITT., *HYMENOGASTER HESSEI* SOEHNER AND *ELAPHOMYCES ACULEATUS* VITT.

(i) **Gautieria morchellaeformis** Vitt.

Two collections (H14 and 110) were made on 7 September 1949 and 14 May 1950, respectively, in a beechwood at Westridge, Wotton-under-Edge, Gloucestershire. The collections were made some distance apart on the outer edge of a path below which the ground fell away steeply to the west. The situation was thus well drained. A mass of greyish white, chalk-like mycelium extended over a considerable area within the layer of beech leaf litter and the top layer of the underlying soil and was particularly dense around fibrous beech roots with which it was obviously forming ectotrophic mycorrhiza. No rhizomorphs were formed and the fruit-bodies arose as denser masses of mycelium among the beech roots. The surface of these masses became wrinkled and indented (Fig. 2A–C), and at no stage could any definite peridium be detected. The wrinkling became more complex so that mature fruit-bodies were a spongy, fleshy mass of up to 2·5 cm. diameter. When first exposed they were dingy white,

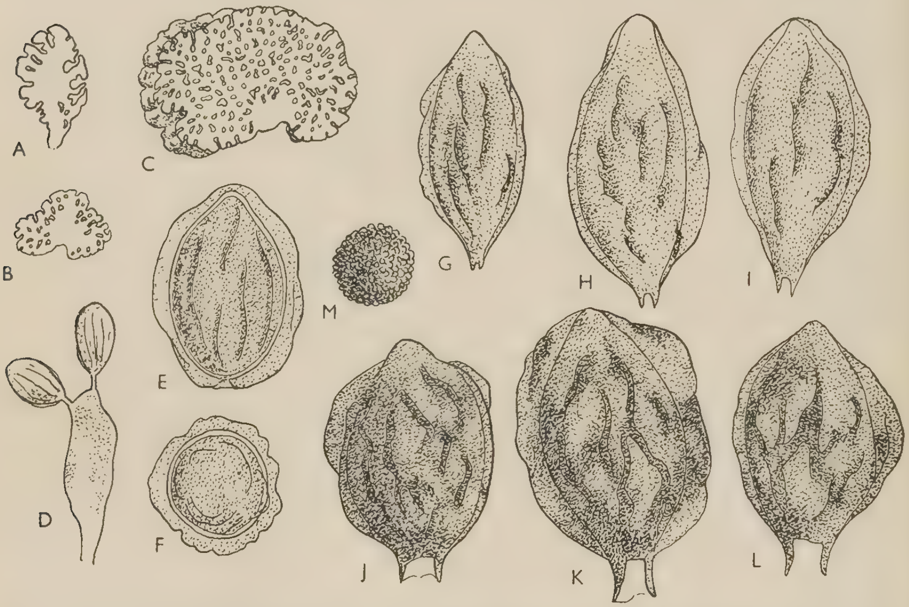


Fig. 2. A–F: *Gautieria morchellaeformis* Vitt. A, longitudinal section of young fruit-body, showing absence of peridium and development of peripheral folds (× 2); B, C, longitudinal section and half fruit-body of older specimens, showing increasing complexity of folds, giving appearance of small isolated chambers, and progressive reduction in extent of basal sterile area (natural size); D, basidium with nearly mature spores (× 500); E, F, mature spores (F viewed from apex) (× 1300). G–I: *Hymenogaster vulgaris* Vitt., mature spores (× 1300). J–L: *H. hessei* Soehner, mature spores (× 1300). M: *Elaphomyces aculeatus* Vitt., mature spore (× 750).

becoming ochre-brown and finally dark brown on exposure, but never reddish brown as recorded by Winter (1884). Sections through young specimens (Fig. 2A) showed a central columella, but in older specimens (Figs. 2B, C) this was reduced to a small sterile basal cushion. The cut surface of young fructifications was white or oatmeal coloured, that of older ones was mottled owing to the presence of numerous brown spores within the labyrinthine wrinkles. The hymenium lining the inner cavities of these wrinkles consisted of carrot-shaped basidia (*c.* 40 × 12 μ), bearing two ovoid, golden brown, longitudinally wrinkled spores on short sterigmata (Fig. 2D–F). Spore size varied through the range 16·5–19 × 10–12 μ (av. 18 × 11 μ). Fertile basidia did not develop over the exposed parts of the fruit-body which were covered with a layer of short chains of relatively thick-walled spherical cells which was continuous with the fertile parts of the hymenium. The fruit-bodies were odourless.

(ii) **Hymenogaster hessei** Soehner

A large number of collections of outwardly similar specimens of *Hymenogaster* have been made mainly in Gloucestershire and Somerset but also in Herefordshire, Carnarvonshire, and Perthshire. Most of the specimens were found under beech or evergreen oak but a few were under other deciduous trees. The fruit-bodies were more or less globose but slightly flattened and longitudinally wrinkled, particularly towards the base. The peridium was dingy white to dull grey and was relatively tough. The gleba was white in young specimens and in some mature ones was reddish brown and in others almost black. The cavities were large, giving a soft spongy texture and the sterile base was absent or inconspicuous.

The spores of those forms with the dark gleba were, however, distinct in size, shape and colour from those of light-coloured forms. The latter (Fig. 2G–I) were typical of *H. vulgaris* Tulasne, as seen in type material at the Royal Botanic Gardens, Kew, and as figured by Massee (1889) and by Dodge and Zeller (1934). They were golden brown, more or less spindle-shaped (av. 25 × 11 μ) with a wrinkled utricle, a fairly well-developed apiculus and a small claw-like structure at the base at the point of attachment to the sterigma. Spores of the dark specimens were dark brown to black, relatively shorter and broader (av. 23 × 14 μ) with a coarsely wrinkled or almost reticulate utricle, sometimes with a well-developed apiculus but occasionally muticate and with a very broad claw-like basal structure (Fig. 2J–L). These resembled spores figured by Hesse (1891) and attributed by him to *H. vulgaris*. Soehner (1923) maintains that the spores figured by Hesse were of a distinct species for which he proposed the name *H. hessei*. Dodge and Zeller (1934) agree with Soehner.

While it is clear that typical material of *H. hessei* differs markedly from typical material of *H. vulgaris*, a very close series of intermediate forms has been found. The best interpretation of this range of forms is probably that typical material of the two species is distinct, but that they are sufficiently closely related to permit the development of intermediates through intermingling of the mycelia and a consequent anastomosis of the hyphae leading to a heterokaryotic condition. The two types of spore were never found in the same fruit-body and were obviously not stages in development. If the specific difference is accepted *H. hessei* must be added to the list of British species of *Hymenogaster*.

(iii) **Elaphomyces aculeatus** Vitt. = *E. rubescens* Hesse

A single collection (H 15) of this species was made at Synwell Hill, Wotton-under-Edge, Gloucestershire, on 7 September 1949, in a small beech wood sloping to the west. Search was made on several subsequent occasions without success and the trees have since been felled.

The fruit-bodies are distinguished from other British species of *Elaphomyces* by the dark grey spiny cortex and the relatively small spores (av. 14–17 μ, Fig. 2M) which agrees with the description given by Dodge (1929).

Thanks are due to Miss E. M. Wakefield for supplying the Latin diagnosis, to her and to Dr R. W. G. Dennis for confirmation of the varietal difference of the material of *Hydnangium carneum* from the type and for confirming the identification of the other species, to Miss J. Fraymouth, Miss V. O. Nicholls, Mr B. E. J. Wheeler and Mr J. F. Spilsbury who made some of the collections and to Miss T. M. Norman for making a preliminary investigation of some of the material of *Hydnangium*.

REFERENCES

Bataille, F. (1923). Flore analytique et descriptive des Hyménogastracées d'Europe. *Bull. Soc. mycol. Fr.* **39**, 157–196.

Cunningham, G. H. (1944). *The Gasteromycetes of Australia and New Zealand.* Dunedin.

Dodge, C. W. (1929). The higher Plectascales. *Ann. mycol., Berl.*, **27**, 145–184.

Dodge, C. W. & Zeller, S. M. (1934). *Hymenogaster* and related genera. *Ann. Mo. bot. Gdn*, **21**, 625–708.

Dodge, C. W. & Zeller, S. M. (1936). *Hydnangium* and related genera. *Ann. Mo. bot. Gdn*, **23**, 565–598.

Hesse, R. (1891). *Hypogaeen Deutschlands.* Bd. **1**, *Die Hymenogastreen.* Marburg.

Massee, G. (1889). A monograph of British Gastromycetes. *Ann. Bot., Lond.*, **4**, 1–103.

Soehner, E. (1923). Berichtigungen zu den in Dr. Rickens Vademecum aufgeführten Hymenogastreen. *Z. Pilzkunde*, **2**, 156–158.

Smith, G. (1951). The Bangor Foray. *Trans. Brit. mycol. Soc.* **34**, 250–256.

Winter, G. (1884). Die Pilze. Rabenhorst, *Kryptogamen-Flora*, Bd. **1**. Leipzig.

(*Accepted for publication* 25 *January* 1952)

GENERIC NAMES IN CLAVARIACEAE

By E. J. H. CORNER, *Botany School, University of Cambridge*

The following species are proposed as lectotypes:
Clavaria botrytis Fr. for *Ramaria* Holmsk. ex S. F. Gray *emend.* Donk.
Lachnocladium brasiliense Lév. for *Lachnocladium* Lév.
Pterula plumosa (Schw.) Fr. for *Pterula* Fr.

Cladaria Ritgen is a synonym of *Ramaria* Holmsk. ex S. F. Gray.
Donkella Doty is a synonym of *Clavulinopsis* van Overeem.

Detailed arguments are provided with reference to original material of the type-species and to extensive monographic revision.

Though my *Monograph of Clavaria and Allied Genera* (Corner, 1950) was completed in 1946, publication was not possible before 1950. In the interval there appeared two papers by Doty (1948*b*, 1950) concerning the typification of clavarioid genera, which I was unable to consider because I was not aware of them until the page-proof of my monograph had been passed. Doty's proposals differ so profoundly from mine that the nomenclature of these fungi may be thrown into confusion if the errors on which his conclusions rest are not explained. The errors arise largely through lack of acquaintance with these fungi, and so they may not be evident to others similarly placed (Rogers, 1949, 1950). In 1946 in correspondence, and in 1947 through a personal visit to the author at Evanston, Illinois, I explained the nature of my monograph and my generic concepts, and I waived my intention of describing a new genus in favour of his *Clavicorona* (1947). I was surprised, therefore, to read his contradictory proposals, particularly as he used unpublished information of mine in another paper (Doty, 1948*a*). I must take the opportunity of refuting the suggestion that I followed Doty in my classification (Wakefield, 1951), and of disclaiming the use of the word 'clavarioid' for cantharelloid fungi, such as *Cantharellus* and *Craterellus*, as well as for such unrelated genera as *Trogia* and *Xerotus*, to all of which Doty has extended the adjective.

RAMARIA Holmsk. ex S. F. Gray emend. Donk

This is the critical genus. I followed Donk's proposal (1933) to base *Ramaria* auct. on *Clavaria botrytis* Fr., but I referred the validation of *Ramaria* Holmsk. to S. F. Gray (1821), instead of to Bonorden (1851), as Donk (1933, 1941) had done. Doty now proposes *Clavaria rugosa* Fr. as the lectotype for this genus, which means that the ninety-seven species of *Ramaria* sensu mihi should become *Clavariella* Karst., in opposition to Donk's subjugation of this genus, 17 years earlier, as a superfluous name; that the thirty-two species of *Clavulina* in my monograph should become *Ramaria* sensu Doty; and that *Clavulina* should become the superfluous name. But the real difference between us is that I monographed the species of the world before coming to a conclusion, whereas Doty seems to have been acquainted only with some North American species. I will review under six headings the arguments that lead me to follow Donk, and then, under seven headings, Doty's proposals.

(1) A genus is needed for the group of clavarioid fungi to which *Clavaria botrytis* belongs. The group is distinguished by the branched fruit-body, the ochraceous to brown spores, and the monomitic, inflating hyphae without secondary septation. It is the largest and one of the more characteristic groups of these fungi; it includes many common species and is almost cosmopolitan. Any attempt to classify a 'Clavaria' necessitates recognition of these characters. Yet, it has taken 160 years to arrive at this conclusion, and only now can the three characters be seen in proper perspective.

(2) *Ramaria* Holmsk. (*Beata Ruris*, 1790) introduced the first character. Holmskjold wrote (p. 16): '*Clavaria simplex* est...*Ramaria composita* est sive in ramos divisa....' He called *Clavaria botrytis* '*Ramaria coralloides* var. *alba apicibus purpureis*'. In this simple sense, too, the genus has been taken up either as a genus or as a subgenus from Fries onwards till 1933. In most cases the authors have cited Holmskjold as the founder, so that the history of the name *Ramaria* is clear, but in all cases, until 1933, many other species which were clearly related to those with simple fruit-bodies were placed in the genus along with the true allies of *Clavaria botrytis*. Thus the genus has appeared unacceptable.

(3) Donk (1933) emended the genus to include only the species with coloured spores: the others he placed in *Clavaria* and *Clavulina*. He dated the genus from Bonorden (1851), who raised *Clavaria* Fr. subgen. *Ramaria* Fr. (*Epicrisis*, 1838) to generic rank, but he traced the concept back to Holmskjold. Fries did not acknowledge the authorship of the name till 1874 (*Hymenomycetes Europaei*), but he cannot have been unaware of it in 1838, or even in 1821 when he used the name 'Ramarieae' for Persoon's 'Coralloideae' beside which *Ramaria* Holmsk. is given as an alternative (*Syn. Meth. Fung.* 1801, pp. 585–95): Fries also cited Holmskjold in 1821. Accordingly, Donk chose as lectotype of the genus *Clavaria botrytis* Fr., a well-known species given both by Holmskjold and Fries and, therefore, typical of their generic and subgeneric entities. He cited the genus as *Ramaria* (Holmsk. ex Fr.) Bon. Thus was introduced the second character.

(4) In my monograph (Corner, 1950), I added the third character of the hyphae, and I realized from the world-flora how well the name characterized the group. With one highly dubious exception, it does not contain a single unbranched species, whereas *Clavaria*, *Clavulina*, and *Clavulinopsis* contain both simple and unbranched species. These three genera, evaluated microscopically, make the discordant element in *Ramaria* auct., and, when removed, show plainly what mycologists have been endeavouring to establish by this genus. I referred it to S. F. Gray (1821), whose work had been given post-Friesian status after Donk had studied the problem and who thus antedated Bonorden in the validation of Holmskjold's genus. The full phrase should be '*Ramaria* Holmsk. (1790) ex S. F. Gray (1821) emend. Donk (1933)', for it does not matter whether Fries, Gray, Bonorden, Quélet, or anyone else validated Holmskjold's genus. Its sense remained that of Holmskjold until Donk's emendation.

(5) *Clavaria botrytis* Fr. was made the lectotype by Donk because it was clearly described both by Holmskjold and Fries, and because it was one of the better known, if not the best known, of clavarias. Persoon called it *C. botrytis*, and Fries adopted this epithet. Schaeffer (1772) had called it *C. acroporphyria*. Hence the two combinations have arisen for the one species, *Ramaria botrytis* (Fr.) Ricken and *R. acroporphyria* (Schaeff.) Quél.

It is important to realize, with respect to §13 (below), that *Clavaria botrytis* has been known from time immemorial as an esculent. Its appearance was bound to attract early man, even if it were unknown in pre-hominoid dietary. No other clavaria has been so much eaten. No other has been so profusely, consistently, and excellently illustrated. Saccardo lists fifty-six illustrations for it, compared with fifty-three for *C. pistillaris*, forty for *C. flava*, and much fewer for other species. In 1777 (*Flora Scotica*), Lightfoot wrote: 'It is reputed to be one of the best of the fungous tribe for the table, and is eaten by the Germans under the name of Ziegenbart.' In 1842 Harzer gave a splendid illustration and wrote 'Häufig...Dieser Pilz, einer der bekanntesten....' In 1874 Fries wrote of it '*Antiquitus celebrata*...'. And so the story is continued to the present time in Europe, where the fungus is still offered in the markets for consumption.

(6) The spores of *C. botrytis* are ochraceous, smooth and finely striate, as noted by Maire (1911) and confirmed by Cotton and Wakefield (1919). That they were ochraceous was shown by Schaeffer (*Fung. Bav.* 1772, t. 176, f. v). Holmskiold paid no attention to spore-colour, and it is clear that no one else in Europe worried about the spores of this well-known esculent, just as very few mycologists know to-day that *Cantharellus cibarius* has coloured spores. Nevertheless, Fries thought that *Clavaria botrytis* had white spores: he continued the error throughout his life, even suggesting that Schaeffer had shown them to be white (*Epicr.* p. 571); and others copied the great Fries. The mistake was immaterial to the generic position of *C. botrytis*, because spore-colour was not considered as generic until Donk's emendation, by which time the point had been cleared up.

These are the arguments for accepting *C. botrytis* as the lectotype of *Ramaria* Holmsk. ex auct. and thus defining the genus in the most satisfactory way. Doty's counter-proposals may now be considered.

(7) Gray (1821) was the first to validate *Ramaria* Holmsk. and, in doing so under this very name and authorship, he gave eight species for the British flora (as listed in my monograph, 1950, p. 124), but naturally did not refer to such Danish species described by Holmskjold as had not been recorded for the British Isles. Gray was not much of a mycologist and he overlooked Lightfoot's record (1777) of *Clavaria botrytis* from Scotland. Because of this mischance, Doty argues that the lectotype of *Ramaria* must be taken from the eight species mentioned by Gray, and that *Clavaria botrytis* must be excluded. Here, however, is a fundamental error, quite apart from Gray's oversight. Doty's proposal would be correct, if Gray had described *Ramaria* as a new genus '*Ramaria* Gray'. But, he took Holmskjold's genus and diagnosis and merely put in it what

British species he had to list. The original material for the nomenclatorial consideration of the genus lies in Holmskjold's species. If Gray had listed no species at all, the situation would have been the same, for he validated *Ramaria* Holmsk. by citation. By excluding the non-British species, as omitted by Gray, Doty excludes a part of the original material of the genus, and there is no evidence at all that Gray intended to amend the genus on such, or any other, grounds. Thus, Doty is in error in ignoring that part of the original material which Donk considered when he proposed *Clavaria botrytis* as lectotype.

(8) The original species of *Ramaria* Holmsk. were twelve. Two were transferred to *Calocera* by Fries, one to *Thelephora*, one to *Isaria*, and one to *Lentinus* or *Polyporus squamosus*, as an abortive state. Of the remaining seven, three only were given by Gray in his British flora, namely:

'*R. amethystina* Holmsk.	as	*R. amethystea* (Bull.) Gray
R. muscoides Holmsk.	as	*R. corniculata* (Pers.) Gray
R. fastigiata Holmsk.	as	*R. pratensis* (Pers.) Gray.'

Doty (1948*b*) used *Ramaria amethystina* to typify *Cladaria* (see p. 290). In 1950, when proposing lectotypes before the International Botanical Congress at Stockholm, he used *Ramaria corniculata* (=*R. muscoides*, *R. pratensis*, and *R. fastigiata*) to typify a new genus *Donkella* (see p. 291). Thus he compelled himself to find a type for *Ramaria* from the species not given under the genus by Holmskjold. Here is his second error. If his thesis were tenable, *R. corniculata* should have been used as the type of *Ramaria* Holmsk. ex S. F. Gray, instead of making it into a new genus: indeed, Donk (1950) proposed this, without appreciating the point made in the preceding section. However, Doty chose *R. rugosa* (Bull.) Gray as the lectotype of *Ramaria*, and here, as will be seen, is another and astonishing error.

(9) *Clavaria rugosa* Fr. is the earliest valid name for *Ramaria rugosa* (Bull.) Gray. It is a very common and variable fungus in Europe. Its fruit-bodies are generally simple, but sometimes they are rather stuntedly branched. For this reason it is the species which, more than any other, has militated against the use of *Ramaria* in every sense until that put forward by Donk. Bonorden, in ignorance of Gray's work, carefully pointed out that the vague branching of *Clavaria rugosa* was not characteristic of the precise branching, by the formation of new growing points, of the species which he referred to *Ramaria*: therefore he excluded *Clavaria rugosa* from *Ramaria* and placed it in *Holocoryne* Fr. ex Bon. This point has escaped Doty, but it is very important, because mycologists will surely refuse a course which places as the type of a genus a species that has been excluded and which has always been a stumbling block to the acceptance of the genus. But, further, *Clavaria rugosa* grades into *C. cristata* and this intermediate, subramose form, which I have called *C. rugosa* var. *alcyonaria*, has been a source of confusion with *C. krombholzii* (=*Ramariopsis kunzei* var. *deformis* mihi). When, therefore, Doty (1950) writes that *Ramaria rugosa* (Fr.) S. F. Gray is readily identifiable, he falls into the error which has beset all students of these fungi until Coker (1923) showed how *Clavaria kunzei* (=*Ramariopsis kunzei*) could be dis-

inguished by its spores. Without authentic dried material one cannot know what was intended by branched forms of *C. rugosa*, and one must uppose that Doty is primarily considering this state of *C. rugosa*. This is is fourth error, arising from lack of acquaintance with the European lora.

(10) *Clavaria cristata*, as just noted, is very close to *C. rugosa*, and many are he apparent intermediates between them, as Coker noted. Yet, Doty, not ontent with one genus for them, uses *C. cristata* to typify *Clavulina* Schroet. 1888). Now only two mycologists have ever put these species into two enera. The first was Holmskjold, who did not know the branched state of *lavaria rugosa* (see §11). The second was Bonorden, who considered that *. rugosa* had simple fruit-bodies. Quélet and Schroeter did not separate hem, and Doty gives no reason for imposing this blind on scientific omenclature. It is his fifth error, and, if his proposals are carried out, *lavulina* will be legitimate for the branched species of the genus and *amaria* for the *unbranched*, in abnegation of the original definition of *amaria*.

(11) Did Holmskjold overlook *Clavaria rugosa*? So common a fungus ould hardly have escaped him. The fact is that it did not, but this act has escaped others, including Doty. Under *C. fragilis*, Holmskjold lescribed two varieties '*a*' and '*b*'. His illustration of *C. fragilis* '*b*' shows he clavate, obtuse, stipitate, rugulose, and gregarious (not caespitose) lubs of *C. rugosa* in its usual simple state, as do in all probability his igs. *a–e* of *C. fragilis* '*a*'. But the illustration of *C. fragilis* '*a*', fig. *f*, hows the fusiform, caespitose clubs of *C. vermicularis*, with which it is ustomary to identify *C. fragilis*. None of his illustrations of *Ramaria* can epresent *Clavaria rugosa*. Thus, Doty has proposed as lectotype of the enus, not merely an atypical species, but one that was deliberately xcluded by the author of the genus. This sixth error completes the *eductio ad absurdum*.

(12) Spore-colour. Nevertheless, Doty continues with the assertion hat *Ramaria* must be defined on a white-spored species because, by hance, the eight species listed by Gray are now known to have white pores. The point has no weight, because spore-colour was not a generic eature of *Ramaria*, until Donk's intentional emendation. A perusal of Gray's work will show that he was totally ignorant of spore-colour in Hymenomycetes (thus, he was far behind Schaeffer, and it is a great ragedy to mycology that this work of Gray's, pre-Friesian in scope and oncept, should come to have a few months' validity for nomenclatorial onflicts, after more than a century's oblivion). But this is Doty's seventh rror.

(13) *Clavaria botrytis* is an uncertain species according to Doty, who, a last effort to try to show that European mycologists do not know their ommon fungi (see §5), advances these three reasons. Coker had difficulty identifying herbarium material of the European *C. botrytis*, but this oes not militate against the species as a living organism: rather does it how the travesty of biology. Then, there has been confusion over the ore-colour of *C. botrytis*, but this is a simple error, long-rectified when oty wrote: no one would use the argument for disapproving *C. cibarius*

(orange-pink spores) as typical of *Cantharellus* (white-spored, even according to Doty). Lastly, Doty complains that Quélet did not recognize *Clavaria botrytis* in *Ramaria*, and this may seem important because Quélet was the first to encourage the use of *Ramaria* by means of many new combinations. Quélet called it *R. acroporphyrea* (Schaeff.). So, when Doty (1950) writes of *Clavaria botrytis* 'until a study of type-material of this species is made, it is not clear just what fungus should bear this name. . .', his ignorance of European mycology leads him into his eighth error.

Conclusions

(i) The basis of *Ramaria* auct. is *Ramaria* Holmsk. (1790), validated by S. F. Gray (1821).

(ii) Donk's emendation (1933) accordingly stands, because it referred to *Ramaria* Holmsk., though through uncertainty of the validity of Gray's work in 1933 Donk referred the validation of the genus to Bonorden through Fries.

(iii) So emended, with *Clavaria botrytis* Fr. as lectotype, the genus represents the only natural and relevant group of clavarioid fungi in which the fruit-body is always branched.

(iv) This use of *Ramaria* stabilizes the generic nomenclature of clavarioid fungi with the least disturbance of binomials.

(v) Doty's alternative, to use *Clavaria rugosa* Fr., is based on eight serious errors and results in the absurd proposal to use as a type a species excluded by the author of the genus, and to use the genus in a sense exactly opposite to that for which it was intended.

CLADARIA Ritgen 1828

This genus was made merely for branched species of *Clavaria*: the original 'description', if such it can be called, is quoted by Rogers (1950) under *Ramaria*. As such it is a superfluous name for *Ramaria* Holmsk. ex S. F. Gray, and I regard it as a clear synonym. Indeed, the content of the genus, as evidenced by the illustrations cited by Ritgen, is that of Holmskjold. Nevertheless, Doty has endeavoured to maintain the name by suggesting *Clavaria amethystina* Fr. as the lectotype. Now, what is *C. amethystina* Fr.? The question illustrates how important it is to know the fungi, whose names one is discussing, before dictating about the names, as I have emphasized elsewhere (Corner, 1951).

In 1933 Donk recognized the confusion over *C. amethystina*, and proposed, as I have stated and followed in my monograph, that *C. amethystina* Fr. should be retained for the *Clavulina* and the binomial *Clavaria zollingeri* used for the species with normal, 4-spored, basidia. Seventeen years later Doty uses *C. amethystina* Fr. for the 4-spored species, without reference to Donk's work. Thus, his type-species for *Cladaria* is a *nomen confusum*. Actually, there is no reason whatever why *Clavaria amethystina* should be taken as the type of *Cladaria*. It may be noted, too, as evidence that it is necessary to know one's fungi before dictating about them, that Doty was unaware that his *Cladaria amethystina* (Fr.) Doty had the hyphal characters of *Clavaria*, as he gave them in 1948, following my vice in 1947. *Cladaria amethystina* sensu Doty, haud sensu Fries is a true *avaria*, with fruit-body varying from almost simple, if caespitose, to ther profusely branched, as given in my monograph.

With regard to the interpretation of *Clavulina amethystina* Fr., I am nvinced that Donk must be followed. There is no means, as yet, for stinguishing certainly from old descriptions and illustrations between *amethystina* (Fr.) and *Clavaria zollingeri*. I think that Bulliard's illustra- on (*Hist. Champ.* t. 496, f. 2) is *Clavulina amethystina*, on account of its rm, and because Bulliard mentioned how near it was to *Clavaria* *alloides* (= *Clavulina cristata*). On the other hand, *Ramaria amethystina*, illustrated and described by Holmskjold, is probably *Clavaria zollingeri*, one can judge from its brittle texture and manner of branching.

DONKELLA Doty 1950

is genus was based on, and proposed solely for, the almost cosmopolitan d common *Clavaria corniculata* Fr. The genus is an example of the shness of proposing genera of fungi without monographic knowledge. I will show, the only characters of the genus which will bear scrutiny e the white spores and the clamped, inflated hyphae, which are the aracters of *Clavulinopsis* given by Doty (1948*a*), on my advice tendered 1947. *Clavaria corniculata* has about fifty allies, some of them very mmon species, as shown in my monograph, and I know of no means of stinguishing them into smaller genera. Thus, *Donkella* is a synonym of *avulinopsis*. I will discuss the generic characters under five sections.

(1) The fruit-body of *Donkella* is described as dendritically branched. e fruit-body of *Clavaria corniculata* is dichotomous.

(2) Doty overlooks *C. corniculata* forma *simplex* Donk, which is the rm with simple fruit-body, thus relating the normally branched *corniculata* with the many unbranched species of its alliance. Thus the anched character of the genus at once disappears.

(3) Doty emphasizes the yellow colour of the fruit-body, but overlooks e common lack of any visible pigment in the fruit-bodies of the closely ated *C. subtilis* alliance, the red pigment of the *C. aurantio-cinnabarina* d *C. miniata* alliance, and the umber pigment of the *C. umbrinella* iance: and some species are pink, as in his *Cladaria amethystina*. It uld seem certain that there are pigments characteristic of these genera clavarias, but that is a biochemical problem, not to be generically scribed as forming 'dark or green colors with certain iron salts'.

(4) Doty emphasizes that the basidia are 4-spored, but they may be 3-, or 4-spored in *Clavaria corniculata*, and they are 2-spored normally certain species of its alliance.

(5) Doty uses some data of mine to give, as a generic character, 'ratio basidial volume to spore volume about 2·6 (Corner, 1948)'. But this wrong. The ratio should be (4 × 2·6), as will be clear on referring to ble 1 in my paper in which I carefully gave total spore-volume per sidium in comparison with basidium-volume. Further, this ratio is average and does not refer to individual spores or basidia, among which ratio may vary from (2 × 2·6) to (6 × 2·6). Thus, apart from being

wrong, as given by Doty, the ratio is seen to be useless as it stands, and this is all the more evident from my Table 1 in which, as I stated under the heading, *the species were arranged in natural groups*. Doty brings forward no evidence that he knows better, but continues by saying that, according to my data, *Donkella* comes, in this respect, between the low ratios of the *Clavaria rugosa*-alliance (*Clavulina*) and the high ratios of other species of clavaria. The mean ratios given in my table are:

C. rugosa-alliance (*Clavulina*)	1·3–2·5
C. corniculata-alliance (*Clavulinopsis*)	1·3–3·9
C. vermicularis-alliance (*Clavaria*)	1·1–7·0
C. botrytis-alliance (*Ramaria*)	1·4–6·4
C. pistillaris-alliance (*Clavariadelphus*)	2·2–3·2

It can be seen that Doty's assertion has no justification. In my paper, I gave reasons for doubting any great accuracy in these figures, and in my monograph, from the data in which these ratios had been calculated, I refrained from using them. As Doty knew that my monograph, explaining these alliances, was in the press, I am surprised that he did not refer his point to me for elucidation, but preferred to select one species out of an alliance of fifteen and to use it exclusively and regardless of the complexity of the whole problem.

Conclusion

Donkella Doty is a synonym of *Clavulinopsis* van Overeem, and is erroneously described.

LACHNOCLADIUM Léveillé 1849

The use of this name for a group of well-defined tropical clavarias is clear, but beset with nomenclatural perplexities. It is a substitute for *Eriocladus* Lév. 1846, which Léveillé and everyone else for a hundred years held to be homonymous with the earlier *Eriocladium* Lindl. In my monograph I used the genus for species with the construction of *Lachnocladium brasiliense* Lév., but I refrained from indicating a lectotype in view of the uncertainty of some of the original species. Now I have been able to resolve these problems and, in proposing *L. brasiliense* as the lectotype, am able to show that nomenclatural perplexities largely disappear when it is known what the organisms under discussion are.

Original species. The following list of the seven original species of *Eriocladus*, numbered as by Léveillé, gives their disposition among clavarioid fungi.

209. *Eriocladus fistulosus* Lév. (= *Clavaria fistulosa* Fr., 1828)

In the first place, the epithet is erroneous and should in each case have been *tubulosus*: the point is clear from the Friesian reference. Through the kindness of Dr Seth Lundell, I have been able to examine the type of *Clavaria tubulosus* Fr., which is in the Friesian herbarium and is labelled '*Clavaria tubulosa* Fr., Brasiliae, Lund'. It is a *Lachnocladium* sensu mihi, and I am unable to distinguish from it specifically the Malayan fungi which I called *L. divaricatum* var. *cinnamomeum* and var. *sordidum.* I find the species to be pantropical, as represented by collections in herbaria.

There is no evidence that Léveillé saw the type of the species, but he added a new record 'ad terram, Guyana Gallia. Leprieur (herb. Mus. Par.)'. This very collection was taken by Patouillard as typical of the species and, as Leprieur's collection had brown aculeate spores, it became the basis of Patouillard's erroneous conception of *Lachnocladium* in 1889. In my monograph I followed Patouillard's description of *Clavaria tubulosus* and placed it erroneously in *Ramaria.*

210. *Eriocladus furcellatus* Lév. (= *Clavaria furcellata* Fr., 1830)

Again, this reference is a quotation, for there is no evidence that Léveillé saw the Friesian types, and he did not refer a collection to the species. The syntypes came from Guinea (Roxburgh), Bourbon (Bory), and Brazil (Beyrich). As I have noted (Corner, 1951), the only collection in the Friesian herbarium is Beyrich's and it is *Lentaria surculus* (Berk.) Corner. It is labelled 'Beyrich (Brazil, in truncis arb. putr. Octobro) *Clavaria furcellata* Roxb.'.

Presumably, therefore, Roxburgh's collection should be taken as the basic element of the species, but its whereabouts, as well as those of the Bourbon collection, are unknown. It is by no means sure that they are conspecific, Fries himself noting discrepancies. Thus, *Lachnocladium furcellatus* (Fr.) is a name of uncertain application and cannot be used as a lectotype. It has been so extensively and erroneously applied to tropical clavarias, even to collections of *Xylaria*, that no collection subsequently identified can be accepted as correctly named, and it may well be held to be a *nomen ambiguum.*

211. *Eriocladus scoparius* Lév. (= *Thelephora scoparia* Lév., 1845)

According to the parts of the type-collection at Kew and Paris, this is a species of uncertain position, for it is totally sterile. I have seen five collections in all that are identical, and in every one the fruit-bodies, though well-developed, are without hymenium. It may be an *Aphelaria* or even a *Tremellodendron.*

212. *Eriocladus acicularis* Lév. (= *Thelephora acicularis* Lév., 1845)

According to Singer (*Lloydia*, **8**, 140, 1945) this is a *Ramaria.* It may be *R. cyanocephala* or *R. zippelii*, which cannot be distinguished in the herbarium, without field-notes.

213. *Eriocladus funalis* Lév. (= *Thelephora funalis* Lév., 1845)

The parts of the type-collection at Kew and Paris are conspecific with *E. scoparius*, and are sterile.

214. *Eriocladus compressus* Lév. (= *Clavaria compressa* Berk., 1842)

As the name was published without description by Léveillé, *C. compressa* Berk. must be taken as the basinym, even though Léveillé added a question mark after it. The question-mark refers, surely, to the identification of Zollinger n. 30 (Java), which Léveillé referred to *Eriocladus compressus* (Berk.) Lév., described from Jamaica. There is no evidence that Léveillé saw Berkeley's type, which seems to be *Lentaria surculus* (Berk.) Corner.

215. *Eriocladus brasiliensis* Lév.

This was described as a new species in Léveillé's paper.

[215*a*. *Eriocladus setulosus* Lév. (= *Clavaria setulosa* Berk., 1845).

This eighth species was added by Léveillé later in the same year of the journal in which he published *Eriocladus*. There is no evidence that he saw the type which, in the Kew herbarium, is a species of *Clavulina*.]

Original material. When he made the genus, Léveillé had seen original material of *Eriocladus scoparius*, *E. acicularis*, *E. funalis*, and *E. brasiliensis*. He added the other three, and the eighth, by reference. For this reason I consider that *E. tubulosus*, *E. furcellatus* and *E. compressus* must be excluded from the typification of the genus.

Original definition. The generic characters, given by Léveillé, were the branched form, coriaceous texture, and tomentose surface of the fruit-body, the last two referring to dried specimens. As Léveillé acknowledged, Fries had previously suggested that such a group might be founded for exotic, branched species with 'hymenio velutino', when he described *Clavaria furcellata* in 1830. Fries (*Epicr.* 1838, 576) even went so far as to make the section Velutinae of *Clavaria* trib. *Ramaria*. But Léveillé changed the definition from 'hymenio velutino' to 'rami...tomentosi ubique fructiferi?', and remarked 'à surface complètement tomenteuse'. Thus, he made his own generic characters and gave no indication that he had merely raised the Friesian section Velutinae to generic rank: he gave a new circumscription. One is not compelled, therefore, to take as lectotype the Friesian species, which Léveillé did not know. The species of *Eriocladus* were listed chronologically by Léveillé, the two Friesian species coming first without ulterior purpose.

The generic characters, themselves, have no particular significance. Had Léveillé described *Clavaria stricta* or *C. kunzei*, so common in Europe, from dried material, he would have had to place them in *Eriocladus*, which is merely an artificial form-genus, like most of the early aggregations of mycology. Fries, however, would not have placed them in his section Velutinae, because their hymenia are not velutinate. Here lies the importance of the new circumscription given by Léveillé, and Fries well knew what he intended by hymenium, as can be seen from his treatment of *Pterula* and *Anthina* at an earlier date. Nevertheless, it is not clear, without Roxburgh's collection of *Clavaria furcellata*, what he meant by 'hymenio velutino'. In the case of *C. tubulosa*, he may not have distinguished the hymenium from the sterile surface of the stem and branches, for these are velutinate in the type-specimen, while the incipient hymenium is smooth, as in all species of *Lachnocladium* sensu mihi. In Beyrich's specimen of *Clavaria furcellata* the hymenium, on the other hand, is velutinate or tomentose because it seems to be a character of this species of *Lentaria* that the hymenium, on drying, often disrupts, though it is waxy and smooth in the living state. But, further, the hymenium of Beyrich's specimen had been much browsed upon by mollusca and had acquired for this reason a rough and uneven appearance. The sterile surfaces of the collection are slightly fibrillose, matt, or smooth. Thus, *Clavaria furcellata* may fit the Friesian sectional diagnosis, but not Léveillé's generic diagnosis. On the other hand, *C. tubulosa* fits Léveillé's and not the Friesian.

Lectotype. Why did Léveillé make the genus? This is really the significant point. He had previously described three of the species as *Thelephora*, and had left three more in *Clavaria* where Fries and Berkeley had placed them. Then he came upon a new species which had characteristically tomentose sterile surfaces. It was this species, *Eriocladus brasiliensis*, which impressed him (for he had not himself seen another *Lachnocladium* sensu mihi), and which he straightway placed in the new genus. On this species he made the generic character, and found support, as he imagined, in the opinion of Fries, one of whose species turns out to be congeneric. This is the reason why I consider, *a priori*, *Eriocladus brasiliensis* to be the nomenclatural type of the genus: it reflects the author's procedure. Then, with modern knowledge, we can see that the sterile tomentose surface of the stem and branches is generic for this group of exotic, and tropical, species, and we see how Fries was confused in his sectional diagnosis. Founded, thus, on *E. brasiliensis*, *Lachnocladium* becomes one of the more distinctive, and certainly the most significant, of clavarioid genera.

Eriocladus funalis and *E. scoparius*, being of dubious systematic position, are clearly unsuitable as lectotypes.

E. acicularis, as a lectotype, would render *Lachnocladium* a synonym of *Ramaria* and destroy its very real exotic character.

It remains, therefore, to conserve *Lachnocladium* against *Eriocladus*, which has not been used since 1846, if it is really felt necessary to justify the modern lack of classical education, provided for by retroactive legislation concerning homonyms.

PTERULA Fr. 1825

The interpretation of this genus and the selection of a type provide a case where it is imperative to follow the use established by Fries, who alone considered the genus in the early stages of its upbringing. Fries hesitated (1821), plunged (1825), changed his mind (1832), and then restored his confidence by emendation of the original concept (1849) in a manner which has been followed to the present day, with the effect that there are about 100 binomials for these clavarioid fungi in the genus. The historical facts are these:

1821 (*Syst. Myc.* **1**). On p. 464 *Pterula* was indicated, as a *nomen nudum*, in the words '*Clavaria penicillata* Bull. est typus novi generis (*Pterula*) in sectione tertia militantis, sed e specimine sicco determinare nolui'. On p. 496 there is a description, in small type suggesting the uncertainty, of *Clavaria penicillata* at the end of the genus *Typhula*, without reference to

p. 464, but with the remark 'genus inquirendum'. The species was not indexed. There was no generic description of *Pterula* nor a combined generic-specific description.

1825 (*Syst. Orb. Veg.* p. 90). *Pterula* was here validly published: '*Pterula*...simplex ramosave, cum stipite confluens, apicibus penicillatis. (*Syst. Myc.* **1**, p. 496 in obs. speciebus adde: *Pter. plumosa* Schw. Car. n. 1089, sub Clav.).'

1830 (*Linnaea* **5**, 531–532). Here Fries repeated his generic description and gave, in alphabetical order, *P. penicillata*, *P. plumosa*, and a new species *P. subulata*.

1832 (*Syst. Myc.* **3**, 285). *Pterula* is treated by Fries as a subgenus of *Anthina*, though with the uncertainty that it might really belong to the affinity of *Clavaria* because of the hymenium. Fries listed *Anthina* (*Pterula*) *plumosa*, *A.* (*Pterula*) *subulata*, and *A.* (*Pterula*?) *penicillata*. Under the last, he mentioned that it might be a true *Anthina*, such as *A. flammea*.

1846–9 (*Summ. Veg. Scand.* p. 339). In a footnote to '*Pterula*', Fries emended it to the sense in which it has ever since been employed and definitely excluded '*Clav. ornithopodioides*' (= *C. penicillata*) as a true *Anthina*, under which it was described on p. 465. He began this emendation with the following sentence: 'Ad unicum hujus generis typum europeum (*Pt. subulata* Fries in Linn. 1830; dubie enim addita *Clav. ornithopodioides* Bull. est vera Anthina!) accedunt multae exoticae....'

1863 (*Monogr. Hym. Suec.* p. 2). Fries described the first Swedish specimens of the genus as the new species *Pterula multifida*, from a collection in the Botanic Garden, Uppsala, by E. P. Fries in 1857.

1874 (*Hym. Eur.*). The wrongly conceived *P. penicillata* is not mentioned.

From these facts it is clear that:

(1) In 1821 Fries did not make the new genus *Pterula* because the species (*Clavaria penicillata*) on which it might be founded was dubious (as it still is).

(2) In 1825 Fries had another species (*C. plumosa* Schw.) which confirmed the idea of *Pterula* so that he published the genus with diagnosis and gave as the first binomial in the genus *P. plumosa*; he did not make the binomial *P. penicillata* as the fungus was still dubious to him.

(3) In 1830 the binomial *P. penicillata* was made for the first time, for the sake of consistency but not because Fries was any better informed regarding the fungus (which, indeed, seems not to have been recognized since the time of Bulliard, nearly two centuries ago).

(4) In 1832 Fries wavered, because of the uncertainty of the dubious *P. penicillata*, the affinity of which seemed with *Anthina*, while that of the other two species was with *Clavaria*.

(5) In 1846–9 a knowledge of the numerous tropical species of *Clavaria*-like fungi falling into *Pterula* confirmed the opinion that it was a good genus of Hymenomycetes, so that *P. penicillata* must be excluded, while *P. subulata* was the only European representative of the genus. The earlier *P. plumosa* was the North American representative. Thus 'typus' in this sentence of Fries does not mean 'nomenclatorial type'.

(6) In 1863 Fries described the second European species of the genus known to him.

At the hands of Fries the genus has evolved from *P. plumosa*, through *P. subulata* to *P. multifida*, embracing numerous exotic, or tropical, species. The types of these three species are in the Friesian herbarium, and I have been able to examine them through the kindness of Dr Seth Lundell. All three are congeneric in the sense of *Pterula* as I have used in my monograph, following the customary Friesian tradition. *P. plumosa* is the earliest species and was for five years the only binomial in the genus. It must, therefore, be the type and lectotype in the modern nomenclatorial sense.

In contrast with this conclusion, Donk, Doty and Rogers argue that *Clavaria penicillata* must be the type because it was indicated (not described) as such by Fries in 1821. These authors are misled by the use of the word 'typus' by Fries, and they overlook the fact that the binomial *Pterula penicillata* was made five years after *P. plumosa*. Further, they overlook the fact that *P. plumosa* was the species that caused the publication of the genus, whereas *P. penicillata* was the dubious and discordant element that caused Fries to alter his mind twice, and finally to establish *Pterula* as a genus of Hymenomycetes by excluding *P. penicillata*. Hence, I see no cogency in their assertion.

Now, the identity of *Clavaria penicillata*, so far as I can discover, has not yet been settled. Fries referred in 1821 to dried specimens, but it is not known what they were or where they may be. It is not clear that he ever saw a specimen of the species, which seems to be founded on the illustrations and descriptions of Vaillant and Bulliard. It may be an *Anthina*, it may be a sterile rhizomorph, as of *Coprinus radians*, or it may be an incipient *Pterula*. Therefore, if *Clavaria penicillata* is to be taken as the type of *Pterula*, this genus may be a *fungus imperfectus*, in which sense the generic name has never been used, or it may be an agaric, or it may be a *Pterula*. If either of the first two alternatives be true, then the 100 other binomials in the genus will need to be changed and a new generic name put forward, while the name *Pterula* becomes a synonym of *Anthina* or a *nomen dubium*. The result would merely be confusing and burdensome to nomenclature without gaining any advantage. Moreover, *Clavaria penicillata* was independently given a genus, *Penicillaria* Chev. (1826), even though this name is a later homonym, so that the case of *Clavaria penicillata* is covered without inflicting it upon *Pterula*.

I conclude that *P. plumosa* (Schw.) Fr. should be the lectotype of *Pterula* on grounds of binomial priority, existence of type-material, and consistent usage, and that *P. penicillata* Fr. is the discordant element for *Pterula* as a genus of Hymenomycetes, as it was originally founded, and as the species was excluded by Fries.

REFERENCES

Bonorden, H. F. (1851). *Handbuch der Mycologie*, p. 166. Stuttgart.

Coker, W. C. (1923). *The Clavarias of the United States and Canada*, pp. 1–209. Chapel Hill, N.C.

Corner, E. J. H. (1948). Studies in the Basidium. I. The ampoule effect. *New Phytol.* **47**, 22–51.

Corner, E. J. H. (1950). A monograph of *Clavaria* and allied genera. *Ann. Bot. Mem.* **1**, pp. 1–740. Oxford.

Corner, E. J. H. (1951). Lectotypes in mycology: a taxonomic proposal. *Nature, Lond.*, **168**, 1031–1032.

Cotton, A. D. & Wakefield, E. M. (1919). A revision of the British Clavariae. *Trans. Brit. mycol. Soc.* **6**, 172.

Donk, M. A. (1933). Revision der Niederländische Homobasidiomycetae-Aphyllophoraceae. II. *Med. bot. Mus. Rijksuniv. Utrecht*, n. 9.

Donk, M. A. (1941). Nomina Generica Conservanda and Confusa for Basidiomycetes (Fungi). *Bull. Bot. Gdn. Buitenz.* Ser. 3, **17**, 155–197.

Donk, M. A. (1950). Summary of Proposals to the Special Committee for Fungi, VIIth Int. Bot. Congr. 1950. (Mimeographed circular, April 1950.)

Doty, M. S. (1948*a*). A preliminary key to the genera of Clavarioid Fungi. *Bull. Chicago Acad. Sci.* **8**, 173–178.

Doty, M. S. (1948*b*). Proposals and notes on some genera of Clavarioid Fungi and their types. *Lloydia*, **11**, 123–128.

Doty, M. S. (1950). Nomenclatural principles and rules in reference to certain fungal and algal generic names. *Lloydia*, **13**, 1–28.

Maire, R. (1911). Notes critiques sur quelques champignons. *Bull. Soc. mycol. Fr.* **27**, 449.

Rogers, D. P. (1949). Nomina Conservanda Proposita and Nomina Confusa Fungi. *Farlowia*, **3**, 425–493.

Rogers, D. P. (1950). Supplement. *Farlowia*, **4**, 15–43.

Stevenson, J. A. & Rogers, D. P. (1950). Mycological nomenclature at the VIIth Int. Bot. Congr. *Plant Dis. Reptr.* **34**, 327–333.

Wakefield, E. M. (1951). Review: *A Monograph of* Clavaria *and allied genera*. By E. J. H. Corner. *Trans. Brit. mycol. Soc.* **34**, 138.

(*Accepted for publication* 13 *February* 1952)

LOPHIUM ELATUM GREV.

By G. R. BISBY and M. B. ELLIS,
Commonwealth Mycological Institute, Kew

(With 1 Text-figure)

Lophium elatum is described from Guernsey, and notes are given on other collections of this species, of which *L. dolabriforme* Wallr. is considered to be a synonym.

Greville (1825) described *Lophium elatum* as 'stipitate, compressed, black, transversely striate, dilated gradually from the stipes into an elongated wedge-shaped perithecium'. He noted that the fruit-bodies were about a line (2 mm.) high and similar to the head of a long-shaped hatchet; asci long, filiform, intermixed with paraphyses and containing a few 'very minute sporidia'. He gave good figures of hysterothecia and 'thecae', some of the latter evidently spores since he shows cross-septa. Greville did not name the substratum, but his figure shows it to be wood. The fungus was collected at Appin, Scotland, by Carmichael and we know of no subsequent British collection.

Greville evidently sent material to Fries, who gave notes (1828) on the 'obcornute' fungus 'in lignis putridus Scotiae', adding '(v.s.)', i.e. that he had seen a dried specimen. According to the Rules as revised at Stockholm, the fungus may now be cited as *Lophium elatum* Grev. ex Fr.

Berkeley (1836) included a short description and added 'On fir wood....Apparently extremely rare, as no species [*sic*] remain in the Appin collection.' We are at a loss to interpret this statement for, as Massee (1895) noted, there is a specimen in the *L. elatum* folder in Herb. Berk. at Kew without a label except 'Scotland' in Greville's handwriting. Possibly Greville had loaned this specimen to Fries, who had not returned it by 1836. Dr Malcolm Wilson informs us that there is no specimen of *L. elatum* at Edinburgh. As for Berkeley's remark 'on fir wood', that may have been a *lapsus calami* owing to the fact that the other species of *Lophium* he included, *L. mytilinum*, does occur on wood of conifers. An examination of the wood of the Kew specimen, kindly made by the staff of the Jodrell Laboratory, Kew, shows that it is *Sorbus aucuparia*.

Meanwhile, Montagne (1834) had recorded *Lophium elatum* without description on a bare, partly decayed branch of 'sapin' from Sedan and on ash branches from Briançon. Then Desmazières found a fungus he identified, probably correctly, as *L. elatum* on dry fallen branches of apple and put up exsiccati as *Crypt. France* 1530; he (Desmazières, 1842) published two pages of notes on this fungus, stating that the asci were about $\frac{1}{4}$ mm. long, and presented a coloured figure of asci and the filiform spores. Duby (1862) saw Desm. 1530, but published no new information on the fungus.

Massee (1895) redescribed the Kew material of *L. elatum* and reported that the spores were 180–200 × 1·5 μ, 'almost as long as the ascus'. This was the first and is still the only published measurement of spores of Greville's collection, which we take to represent the type.

We must now go back to 1833 to consider *L. dolabriforme* Wallroth, then described on bark of *Pyrus communis* and *Alnus* in Thuringia: 'ascomatibus erectis utrinque compressis obsolete tenuiterque striatis nigropiceis nitidulis, e basi subaequale infixa (nonnisi parce strigulosa) in apicem truncatum ancipitem desinentibus, siccando fragilissimis, intus cinereo-farctis'. This description might apply to *Lophium elatum*; but Wallroth's preceding species, described in similar terms, was *L. unguiculatum* Wallr. (with *Hysterium pedicellatum* Schum. cited as a synonym) and Wallroth noted '*Lophium elatum* Grev. haud multum differre videtur'.

Duby (1862) examined authentic material of *L. dolabriforme* from Wallroth and figured hysterothecia, asci, and spores. He did not give measurements but, from his figures of spores, stated to be × 300, one would calculate them to be about 100 μ long. Rehm (1886) re-examined this Wallroth specimen on *Pyrus* in Herb. Duby and found that the spores were about 300 × 2 μ; later (Rehm, 1887) he gave the range of spores as 150–300 × 2–3 μ and asci 300–350 × 6–8 μ. Rehm (1886) found that *Lophium unguiculatum* Wallr. and *Hysterium pedicellatum* Schum. were the pedicellate form of *H. pulicare*. He (1887) included *Lophium elatum* Grev. as a doubtful species.

Fuckel (1870) reported *L. dolabriforme* on old bark of *Pyrus communis* and issued exsiccati as *Fungi rhen.* 763. In 1873 he added that he had obtained from Neuchâtel material on bare branches of *Prunus spinosa* which was the same as his material on *Pyrus* (Fuckel, 1873). Lehmann (1886) studied a specimen of Fuckel's *Fungi rhen.* 763, reported the asci to be 300–400 × 9–10 μ and the ascospores 300–400 × 2 μ; he did not find paraphyses. Since the hysterothecia differed much from those of other species of *Lophium* including the type, *L. mytilinum*, he proposed a new genus *Glyphium* Nits. (a manuscript name of Nitschke's) with the one species *G. dolabriforme*.

In 1948 a *Lophium* was collected in Guernsey, Channel Islands. The mycelium, mostly embedded in the substratum, is composed of pale brown to brown, septate, branched hyphae 2–3·5 μ wide. Below each hysterothecium there is a thick bed of brown, closely interwoven and anastomosing hyphae (Fig. 1 *e*). Hysterothecia (Fig. 1 *f*) arise singly or in small groups, are erect or slanting, hatchet-shaped, 1–2 mm. high and up to 0·5 mm. wide with a narrowed base 120–200 μ wide, black with a number of transverse, parallel, shining ridges; short brown hyphae project from the narrow edge of the hysterothecium (Fig. 1 *a*), the walls of which are made up of dark brown to black, thick-walled cells (Fig. 1 *b*). The asci (Fig. 1 *d*) are 200–350 × 6–8 μ, often with long stalks up to 100 × 3·5 μ. The spores (Fig. 1 *c*) are 150–330 × 2–3 μ, narrower at the ends, pale olive when mature, multiseptate. Paraphyses are abundant, hyaline, less than 1 μ wide, closely packed and interwoven, irregularly branched. On old bark of *Lonicera periclymenum* (det. at the Jodrell Lab., Kew), Bec du Nez, Guernsey, 26 September 1948, coll. M. B. and J. P. Ellis.

This fungus agreed well with the descriptions, summarized above, of Wallroth's and Fuckel's collections of *Lophium dolabriforme* Wallr. If Massee's measurements and Desmazières' approximation were right, *L. elatum* should have shorter asci and spores; furthermore, Greville's figures showed narrower hysterothecia and Berkeley had given the substratum as 'fir'. It seemed necessary to make a slide (now filed in Herb. Kew) of a bit of the small amount of fungus remaining on the type of *L. elatum*. Fortunately asci and spores were obtained, and many of the latter were found to be more than 300μ long. Then, as noted above, it was found that the fungus was on *Sorbus*, not 'fir'. It seems certain that *L. dolabriforme* is the same as *L. elatum*, and the latter name has priority.

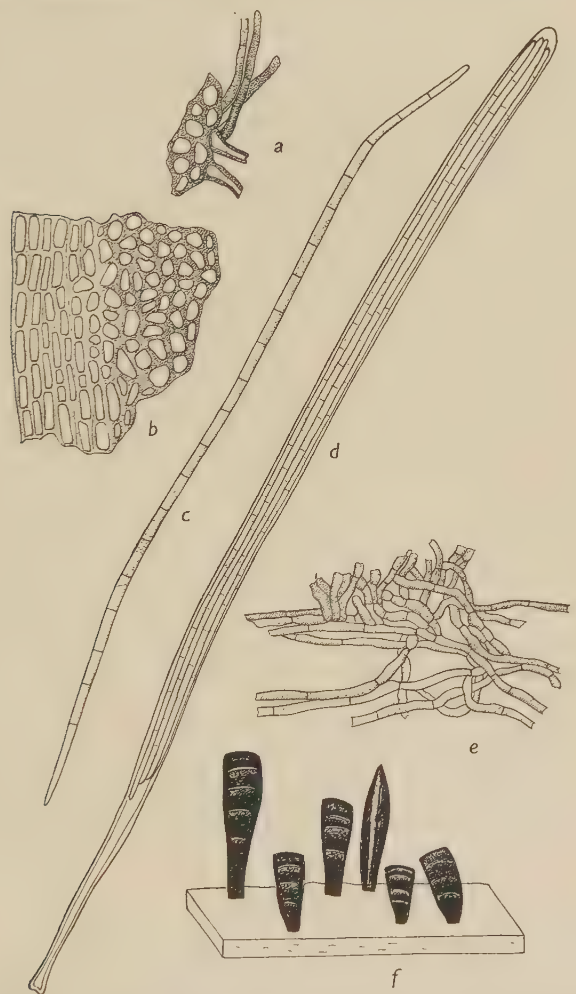


Fig. 1. *Lophium elatum* Grev. ex Fr. *a*, part of edge of hysterothecium; *b*, section through wall of hysterothecium; *c*, ascospore; *d*, ascus; *e*, subiculum; *f*, group of hysterothecia. *a*–*e*, × 500.

Greville's figures of *L. elatum* show fruit bodies narrower than in other collections; as Bisby (1944) noted, they suggest *Acrospermum*, a genus often placed in the Hysteriales and also with filiform spores. Miss Brandriff (1936) concluded, however, that *Acrospermum* is allied to the Dothideales and found that the fructification is typically fleshy-cartilaginous when moist and horny when dry. *Lophium elatum* has a carbonaceous, hysterioid fruit body. If anyone considers that this fungus should be placed in a separate genus, the name *Glyphium* is available. It should be remembered, however, that *Hysterium pulicare* has the forma *pedicellatum* which, as Wallroth noted, simulates *Lophium elatum*; and that the Hysteriales and many other groups of fungi are divided into far too many genera merely on Saccardo's criteria of shape, colour, and septation of spores.

Lind (1913) records 'on barked branches of *Pinus malus silvestris*' four collections of *Lophium dolabriforme*, one of which was issued by Vestergren as *Micromycetes rariores selecti* 921. In response to a query, the Director of the Museum at Copenhagen kindly loaned us the Danish specimens. These were collected on five dates: 21 May 1881, 23 June 1881, 4 April 1882, 19 June 1897, and 20 March 1904. All five specimens bear hysterothecia on the inner or outer bark of apple (the packets are marked either '*Pyrus malus*' or '*Malus silvestris*'). The hysterothecia are like those described above from Guernsey, and a mount of one showed the same filiform spores. We consider the Danish collections to be *L. elatum* (syn. *L. dolabriforme*).

Lophium elatum is apparently known only in Europe where it seems to be one of the rarest of fungi. The numerous collectors since 1825 would have been likely to see and to record or keep such striking hysterothecia, if they had been encountered. The verified or evidently dependable records to date are six collections on apple branches, two on pear, one each on *Sorbus*, *Prunus*, *Alnus*, and *Lonicera*. Montagne's reports on 'sapin' and ash remain unverified.

We cannot claim this collection from Guernsey as a new British record, but it has convinced us that *Lophium elatum* Grev. is a good British species. We hope that now, after a century and a quarter, it may be re-discovered in additional stations between Appin and the English Channel.

REFERENCES

Berkeley, M. J. (1836). Fungi *in* J. E. Smith, *English Flora*, **5**, II, 281.

Bisby, G. R. (1944). The British Hysteriales. II. *Trans. Brit. mycol. Soc.* **27**, 24.

Brandriff, Helen (1936). The development of the ascocarp of *Acrospermum compressum*. *Mycologia*, **28**, 228–235.

Desmazières, J. B. (1842). Neuvième notice sur quelques plantes cryptogames. *Ann. Sci. nat.* (*Bot.*), Sér. 2, **17**, 113.

Duby, J. E. (1862). Mémoire sur la tribu des Hystérinées. *Mém. Soc. Phys. Genève*, **16**, 15–70.

Fries, E. M. (1828). *Elenchus Fungorum*, **2**, 113.

Fuckel, L. (1870). *Symbolae Mycologicae*, p. 93.

Fuckel, L. (1873). *Symbolae Mycologicae*, 2. Nachtrag, p. 19.

Greville, R. K. (1825). *Scottish Cryptogamic Flora*, **3**, pl. 177.

Lehmann, F. (1886). Systematische Bearbeitung der Pyrenomycetengattung *Lophiostoma*. *Nova Acta Leop. Carol.*, **50**, 139.

Lind, J. (1913). *Danish Fungi as Represented in the Herbarium of E. Rostrup*, p. 151.
Massee, G. (1895). *British Fungus Flora*, **4**, 37.
Montagne, J. P. (1834). Notice sur les plantes cryptogames récemment découvertes. *Ann. Sci. nat.* (*Bot.*), Sér. 2, **1**, 346.
Rehm, H. (1886). Revision der Hysterineen im herb. Duby. *Hedwigia*, **25**, 180–182.
Rehm, H. (1887). *Rabenh. Krypt.-Flora*, 2 Aufl., **1**, Abt. 3, p. 27.
Wallroth, F. G. (1833). *Flora Cryptogamica Germaniae*, **2**, 433.

(*Accepted for publication* 30 *January* 1952)

NOTES ON BRITISH HYSTERIALES

By G. R. BISBY and R. W. G. DENNIS,
Kew, Surrey

(With 1 Text-figure)

Mytilidion laeviusculum, *Lophium mytilinum* and *Hysterographium elongatum* are reported from Scotland. The name *Dichaena* is not considered to merit conservation.

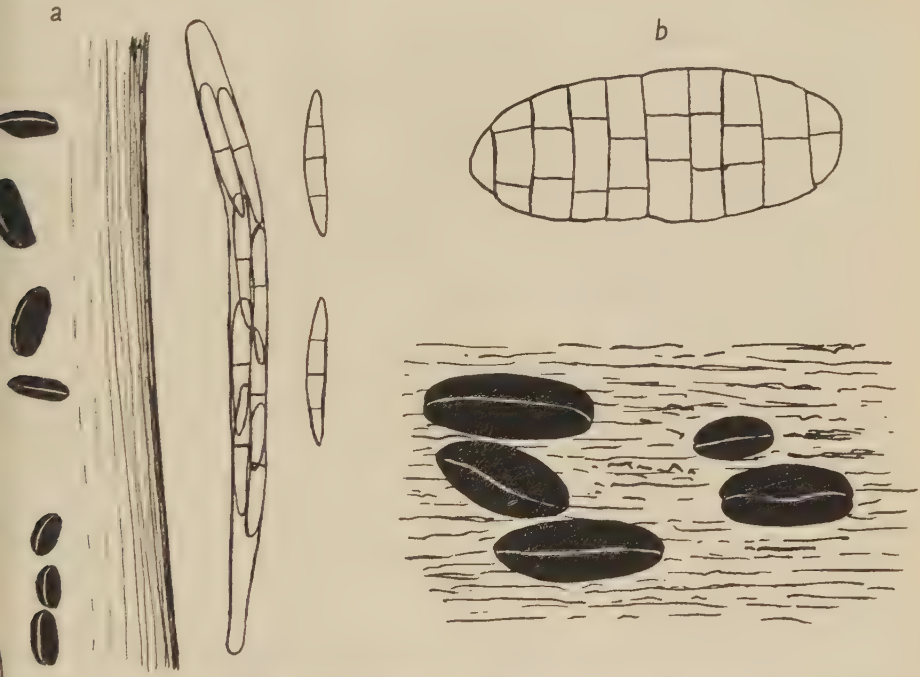
Mytilidion laeviusculum (Karst.) Sacc.

Lophium laeviusculum Karsten (1871) was described 'ad lignum fabrefactum pineum' in Finland. Phillips and Plowright (1880) gave an English translation of Karsten's Latin diagnosis and added: 'On fir leaves. Forres. Rev. J. Keith. The asci in our specimens are 0·05 × 0·004 mm., and the sporidia 0·015 × 0·002–0·003 mm.' They cite without explanation '*Lophium mytilinum, Stev. Myco. Scot.*, p. 349'. Saccardo (1883) transferred *L. laeviusculum* to *Mytilidion* and added the Forres record as 'forma *minor*'. Massee (1895) included this forma but Bisby (1941) omitted it. Keith's collection on pine needles is not represented at Herb. Kew. or Herb. Brit. Mus. Nat. Hist., no subsequent record of a collection on conifer needles had been traced, and it seemed possible that Keith might have had one of the Hypodermataceae.

A collection on dead pine needles and adjacent shoots made at the head of Loch Morlich, Glen More, Rothiemurchus, Scotland, 28 September 1950, by one of us bears erect mussel-shaped, black hysterothecia $\frac{1}{4}$–$\frac{1}{2}$ mm. long. These are accompanied on the needles by a thin web of spreading, brown mycelium without conidia or pycnidia. The asci are up to $80 \times 5\mu$ and the ascospores $18–20 \times 2·5–3\mu$, slightly immature since they show only a trace of olivaceous colour and are mostly one-septate, though some spores are four-celled. This (Fig. 1*a*) is *Mytilidion laeviusculum* and its recurrence on pine needles in Rothiemurchus makes it probable that this was indeed the fungus collected by Keith at or near Forres. There is no noticeable difference between our collection and Karsten's type as redescribed by Lohman (1939), so it is unnecessary to call it 'forma *minor*'.

Cultures from ascospores produced a mass of brown, hair-like, interwoven hyphae with little branching, like those present on the pine needles. No conidia or other reproductive structures were produced. Lohman (1933) obtained the same sort of cultures from the one known American collection of this species.

While there is a possibility that Bucknall's collection near Bristol on 'worked pinewood' (see Massee, 1895) was introduced with the wood (see Bisby, 1941), there is now no doubt that *M. laeviusculum* is a native of Scotland. Very few collections of this species are known. Karsten's ype collection of 22 May 1866 was ample; he issued exsiccati from it as *ungi fenn.* 771 and, as Lohman's photograph (1939) shows, there are nany hysterothecia on the remaining material. We have not found eports of subsequent Finnish collections. Minks (1882) studied a specimen f Karsten's Exs. 771. Schroeter (1893) reported it 'auf altem Holz' in ilesia, but gave no new data on the characters of the fungus. We have ioted no other record of the species from Europe. The single collection nade in America (Lohman, 1933) was on a much-decayed log of *Larix* n Michigan.



ig. 1 *a*: *Mytilidion laeviusculum.* Hysterothecia on pine needle, × 20; ascus and spores, × 1000. *b*: *Hysterographium elongatum.* Hysterothecia, × 10; spore, × 1000.

The rarity of *M. laeviusculum* may be more apparent than real, for ieir small size and dark colour make the hysterothecia inconspicuous. 'he 1950 collection was made for *Pseudohelotium pineti* (Batsch ex Fr.) uckel, and the presence of the *Mytilidion* was noted only when the iaterial was being critically worked over at Kew. The hysterothecia ccurred on the permanently damp lower portion of a heap of cut branches f *Pinus silvestris*.

Hysterographium elongatum (Fr.) Corda

collection on old, decorticated wood of *Salix* at the head of Glen More, othiemurchus, Inverness-shire, 14 May 1949, bears relatively large ysterothecia (1–2 mm. long) with ascospores $44–52 \times 15–20\mu$ (Fig. 1 *b*). 'he morphology of this fungus is like that of *Hysterographium fraxini* except that the latter has ascospores usually golden to cinnamon brown, whereas in this collection they are very dark and opaque. Fries (1823) would have had no hesitation in distinguishing this as *H. elongatum*, which belongs to his Tribus Denudata and is '*Semper ad ligna decorticata Populi, Salicis, Rhamni, &c. Perrene*', whereas *H. fraxini* is in Tribus Erumpentia. Since 1823 European mycologists have maintained the two species though, as Bisby (1944) noted, they are very similar and Fries's distinction between them still seems the best. Hilitzer (1929) described both species at considerable length and found a conidial state he named *Hysteropycnis confluens* associated with *Hysterographium elongatum* and a state he named *Hysteropycnis fraxini* with *Hysterographium fraxini*; but these pycnidial states also seem to be very similar. Zogg (1943) distinguished the two mainly on the character of the septation of the ascospores; but that also seems a rather elusive distinction.

It seems to us that *H. elongatum* and *H. fraxini* should be maintained as distinct species unless and until it can be demonstrated that they are the same. Cultures were, unfortunately, not obtained from the 1949 collection. This and a collection by Keith at or near Forres, Scotland, on decorticated wood, are at present the only British collections known to us which seem to belong to *H. elongatum*.

Lophium mytilinum Fr.

Recent collections of this species were reported (Bisby, 1944) from Yorkshire and the Scottish border. A good collection made by E. W. Mason at the Aviemore Foray in September 1927, now in Herb. I.M.I., was recorded in these *Transactions*, **13**, 311. Another Scottish collection was made on old wood of *Pinus sylvestris* at Moy Castle, Inverness-shire, 13 April 1949, by one of us. This has asci about 200μ long and ascospores $150\text{–}180 \times 2\text{–}2{\cdot}5\mu$, both asci and spores longer than usually found in *Lophium mytilinum*.

Species of *Lophium* and *Mytilidion* on conifers might be expected to be more prevalent in Scotland than in other parts of Britain, but apparently *M. karstenii* and *M. gemmigenum* have not yet been found there.

DICHAENA OR *HETEROGRAPHA*

Until 1870 or later many lichenologists accepted *Dichaena* as a genus of lichens, often using the name *Opegrapha*, sometimes *Heterographa* or other names. We have now gone over the numerous collections formerly filed with the lichens at Kew. The lichenologists had no more success in demonstrating asci than the mycologists subsequently. 'Apothecia' are sometimes noted or described, but the spores when described or figured seem to have been the conidia of *Dichaena faginea*.

The name *Dichaena* dates from 1825 and is preceded by the name *Heterographa* Fée, 1824 (see Rogers, 1950). *Dichaena* is a *nomen conservandem propositum*; but it is a genus with few species, rejected first by lichenologists, now apparently due for rejection by hysteriologists, and not yet accepted by other mycologists, so there would seem to be no one who should worry about the name.

REFERENCES

BISBY, G. R. (1941). British species of Hysterium, Gloniopsis, Dichaena and Mytilidion. *Trans. Brit. mycol. Soc.* **25**, 127–140.

BISBY, G. R. (1944). The British Hysteriales. II. *Trans. Brit. mycol. Soc.* **27**, 20–28.

FRIES, E. M. (1823). *Systema Mycologicum*, **2**, 581.

HILITZER, A. (1929). Monograficka studie o českých. ... Hysteriales. *Proc. Czechoslav. Acad. Agric.* (*Vedecké Spisy vyd. Česckoslov. Akad. Zemĕd.*), **3**, 162 pp.

KARSTEN, P. A. (1871). Symbolae ad mycologiam fennicam. *Not. Sallsk. Fauna Flora Fenn.* **11**, 261.

LOHMAN, M. L. (1933). Hysteriaceae: life-histories of certain species. *Pap. Mich. Acad. Sci.* **17**, 229–288.

LOHMAN, M. L. (1939). Karsten's type specimens of Hysteriaceae on conifers. *Mycologia*, **31**, 354–365.

MASSEE, G. (1895). *British Fungus Flora*, **4**, 25.

MINKS, A. (1882). *Symbolae Licheno-Mycologicae* 2, 124–127.

PHILLIPS, W. & PLOWRIGHT, C. B. (1880). New and rare British fungi. *Grevillea*, **8**, 103.

ROGERS, D. P. (1950). Nomina conservanda proposita and nomina confusa—Fungi. Supplement. *Farlowia*, **4**, 24.

SACCARDO, P. A. (1883). *Sylloge Fungorum*, **2**, 761.

SCHROETER, J. (1893). *Krypt.-Flora Schlesien*, **3**, 2. Hälfte, p. 186.

ZOGG, H. (1943). Untersuchungen über die Gattung Hysterographium.... *Phytopath. Z.* **14**, 310–384.

(*Accepted for publication* 14 *February* 1952)

SUMMARY OF THE BRITISH HYSTERIALES

By G. R. BISBY and S. J. HUGHES,
Commonwealth Mycological Institute, Kew

(With 3 Text-figures)

Numerous recent collections permit a clearer view of several British Hysteriales. The genera and species of *Farlowiella*, *Gloniopsis*, *Hysterium*, *Hysterographium* and *Mytilidion* are summarized below, and a revised key to British species is appended.

Farlowiella

Farlowiella carmichaeliana (Berk.) Sacc., the one known species of this genus, was redescribed by Mason (1941). The name is based on a collection made at Appin, Scotland, before 1826. Specimens of the same species were collected in Leicestershire about 1860 and became the type of the name *F. repanda* (Bloxam ex Duby) Sacc. Bucknall (1886) reported the latter without notes from a collection, now lost, made near Bristol in 1883. Mason added three records of *F. carmichaeliana* on *Fagus* in Surrey in 1934 and 1936.

Nine collections bearing hysterothecia were added to Herb. I.M.I. during 1946 to 1950 from Carmarthenshire, Glamorgan, Surrey, Yorkshire, and Cheshire, the last by W. D. Graddon. Four of these were on *Quercus*, two on *Sorbus*, one on *Prunus*, and two on unidentified wood. We conclude that *Farlowiella carmichaeliana* is not only widespread in Britain, but probably not uncommon. So far as we know, there is still only one record of *Farlowiella* outside Britain and that collection, in Belgium in 1887, was said to have ascospores smaller than those of *F. carmichaeliana*.

Mason demonstrated that the conidial state of *F. carmichaeliana* is *Monotospora megalospora* Berk. & Br. This is a conspicuous Hyphomycete which has been collected several times in Britain and reported a few times from other parts of Europe. The name *Monotospora* should not be used for this fungus, but there is available for this state the valid name *Farlowiella carmichaeliana* stat. conid.

Gloniopsis

Gloniopsis levantica Rehm is now represented in Herb. I.M.I. by some fifty collections on twenty-three dicotyledonous woody hosts and one on *Rumex* stems. These specimens range from Yorkshire southward, westward across Wales and to Cornwall and the Isles of Scilly, and one is from Scotland. To the statement (Bisby, 1941, p. 130) that it is 'to be found in almost any clump of old *Rubus*' should have been added 'in southern England', for Dr Dennis tells us that he searched for it in vain in Scotland where, according to the evidence available, the species seems to be uncommon. But in the southern half of England and probably in Wales it maintains its reputation as the commonest member of the Hysteriales.

We still consider that the British collections can and should be referred to one somewhat variable species and that *Gloniopsis levantica* is the correct name to apply to it. If the type of the name *G. curvata* (Fr.) Sacc. can be shown to be the same as the British species, that name will have priority. Another early name is *G. verbasci* (Schw.) Rehm; it is applied by Zogg (1949) to some sixteen Brazilian collections very similar to those we call *G. levantica*, except that the hysterothecia seem to be smaller in *G. verbasci*.

Watson (1948) noted that the name *G. watsonii* Rilstone refers to the lichen *Graphina ruiziana* Müll.-Arg.

Hysterium

Hysterium angustatum (Alb. & Schw. ex Fr.) Chev. is now represented in Herb. I.M.I. by numerous collections on branches of various broad-leaved trees and shrubs from Yorkshire to Wales and southward. It would appear to be nearly as common as *Gloniopsis levantica* in the southern half of Britain and is found also on the continent of Europe, in North America, in Brazil (Zogg, 1949), and in China (Teng, 1933).

In 1875 *Hysterium berengerii* Sacc. was described from north Italy on *Fraxinus*, and was reported by Rehm (1887) from Franconia on *Quercus*. Ellis and Everhart (1892) entered this name as a possible synonym of *Hysterium insidens*, and Bisby (1932), after examination of a specimen probably authentic, agreed. We can now present evidence that *H. insidens* does occur in Europe, and may be found in Britain. Hughes (1952) has found that '*Septonema spilomeum* Berk.', obtained by Lohman in cultures from *Hysterium insidens* in America and by us in cultures from South African material, is not a *Septonema* but the fungus *Sirodesmium granulosum* de Not., described from Italy and collected a few times in Europe, including Guernsey, in North America, and in Australia; this state is figured by Hughes (1952). There is one record (as *Septonema spilomeum*) from Yorkshire, but no British specimen has been seen by us.

Most of the Hysteriales which have been cultured, including other species of *Hysterium*, form mycelia without conidia or with rather nondescript pycnidia. The conidial state of *H. insidens* is as conspicuous and distinctive as the perfect state. We believe its reputed occurrence in Britain can be confirmed by future collectors. This species seems to favour weathered wood such as fence rails and posts, especially of *Quercus*.

Hysterographium

Hysterographium fraxini (Pers. ex Fr.) de Not. has apparently become rare over much of Britain (see Bisby, 1944). We now find, however, that it still thrives on ash near Aberystwyth, Wales. Collections were made by S. J. H. on 5 August 1947(Fig. 1), 28 May 1949, and 19 July 1951. Prof. Chesters sent part of a collection he made there 1 December 1951 and wrote that it 'evidently has spread since I first saw it near Aberystwyth in April 1938'. Cultures made from the 1947 collection produced the pycnidia which Hilitzer described as *Hysteropycnis fraxini*. For notes on the possible differences between *Hysterographium fraxini* and *H. elongatum* see the preceding paper by Bisby and Dennis.

Hysterographium mori (Schw.) Rehm is now accepted as an earlier name for *H. rousselii* (de Not.) Sacc. (see Zogg, 1943; Bisby, 1944). This species is common in North America and apparently also in South America (Zogg, 1949); it occurs in Europe but is evidently not common in Britain and we have no recent collection. Two specimens were obtained by one of us in the Gold Coast in 1949. The collection of conidial *Hysterium insidens* from Guernsey, mentioned above, has *Hysterographium mori* associated.

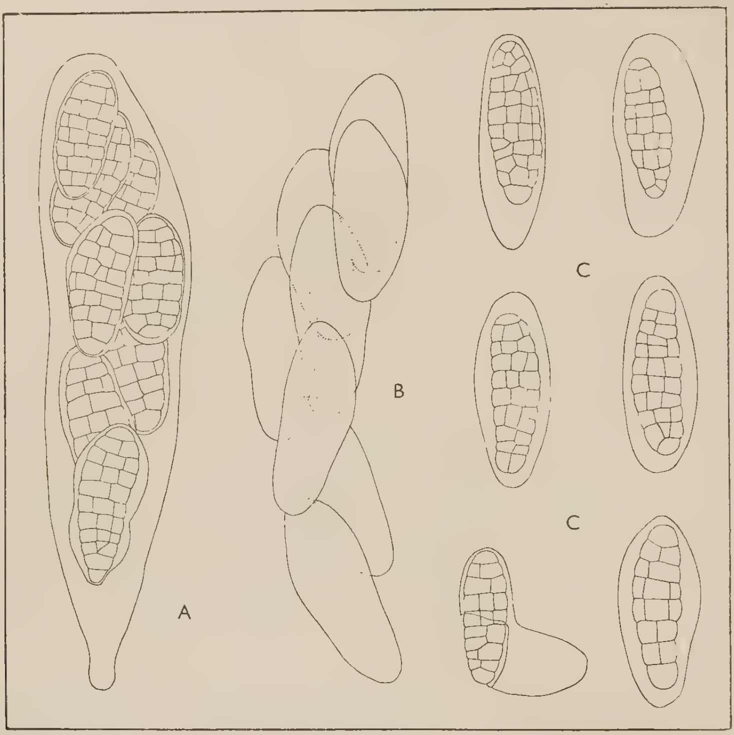


Fig. 1. *Hysterographium fraxini*: from Herb. I.M.I. 17286 (*a*); A, ascus with ripe ascospores; B, preparation in concentrated H_2SO_4 showing disappearance of ascus wall and ascopores contents leaving only the pellicles; C, isolated ascospores, one of which is damaged, in lactic acid showing separation of pellicle from the septate contents; all × 500.

This association of the conidial state of one member with the perfect state of another merely means that both species are adapted to the same substratum, generally firm and dry wood or bark. One collection of conidial *H. insidens* from South Africa had a *Gloniopsis* associated. The association of the perfect states of two species might lead to some confusion, but our experience has been that, when such association does occur, the hysterothecia can usually be seen to arise from separate centres and generally are macroscopically distinct.

Mytilidion

Mytilidion gemmigenum Fuckel was collected 14 May 1949 on *Larix* in Lincolnshire by Miss G. M. Waterhouse (Herb. I.M.I. 35211). Spores were present (see Fig. 2), but the fungus was too old to yield cultures. It may be merely a coincidence that, of the four or five British collections we have seen, only one is 'in good fruit'; or possibly the period of spore discharge is brief.

M. karstenii Sacc. The first known British collection was that by Mrs U. C. Mason in 1937 (Herb. I.M.I. 23123), from which cultures were made from ascospores (see Bisby, 1941). A second collection on wood and bark of *Pinus sylvestris*, Penglais Woods, Aberystwyth, coll. S.J.H. 26 March 1948 (Herb. I.M.I. 27743), is now described (see Fig. 3).

The colonies of conidiophores and conidia on the pine are thin, extensive, and dull black in colour. The *mycelium* is immersed and superficial and is composed of rough-walled, septate, branched hyphae 1·5–5 μ wide, subhyaline to pale brown within the host tissues, dark brown at the surface. The hyphae in the wood run most commonly parallel with the tracheids, but in the medullary rays the hyphae are denser than in the wood and run radially.

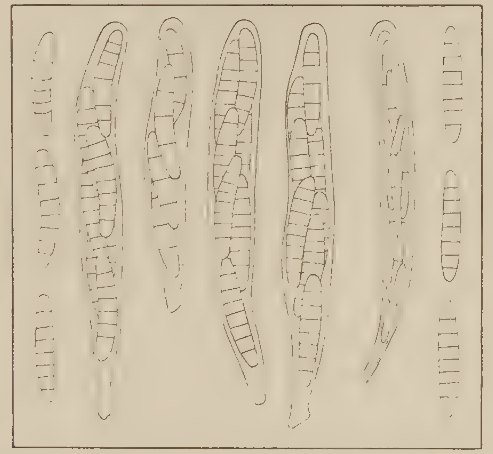


Fig. 2. *Mytilidion gemmigenum*: asci and ascospores from Herb. I.M.I. 35211; × 500.

The *conidiophores* are scattered or crowded over the surface of the wood and bark and even tufted, especially where the medullary rays reach the surface; here the hyphae are densely compacted and the conidiophores are the expanded ends of the hyphae which grow out. From the superficial and semi-immersed hyphae, conidiophores arise as upright lateral branches. They are irregular in shape, generally more or less oval to fusoid or even cylindrical and not particularly different from the conidia, 15–60 × 8–11 μ, 2- to 7-septate, sometimes slightly constricted at the septa, often narrowed below, thick-walled, very dark brown and coarsely roughened. Not infrequently they are forked at the base.

The *conidia* are produced in acropetal succession in single, simple or once branched chains at the apex of each conidiophore. The first conidium arises as a blown-out end of the apex of the conidiophore and further conidia arise subsequently in the same manner from the apex of each previous conidium. At maturity the conidia are very variable in shape but generally fusoid to cylindric-oval, 2- to 7-septate, usually slightly constricted at the septa, coarsely roughened, with barely perceptible scars at each end, thick-walled, very dark brown and 15–35 × 8–11 μ.

The conidial stage of *M. karstenii* agrees with the type species of *Septonema*, *S. secedens* Corda (Hughes, 1951) sufficiently for it to be referred to as the *Septonema* state of *Mytilidion karstenii*. No independent name for the conidia is known in Herb. I.M.I., but it seems unlikely that this fungus has been overlooked and not assigned to a binomial. Lohman (1939) observed *Septonema* conidia, in addition to the hysterothecia, on a collection identified as *Mytilidion karstenii* in P. A. Karsten's herbarium, which Lohman chose as lectotype.

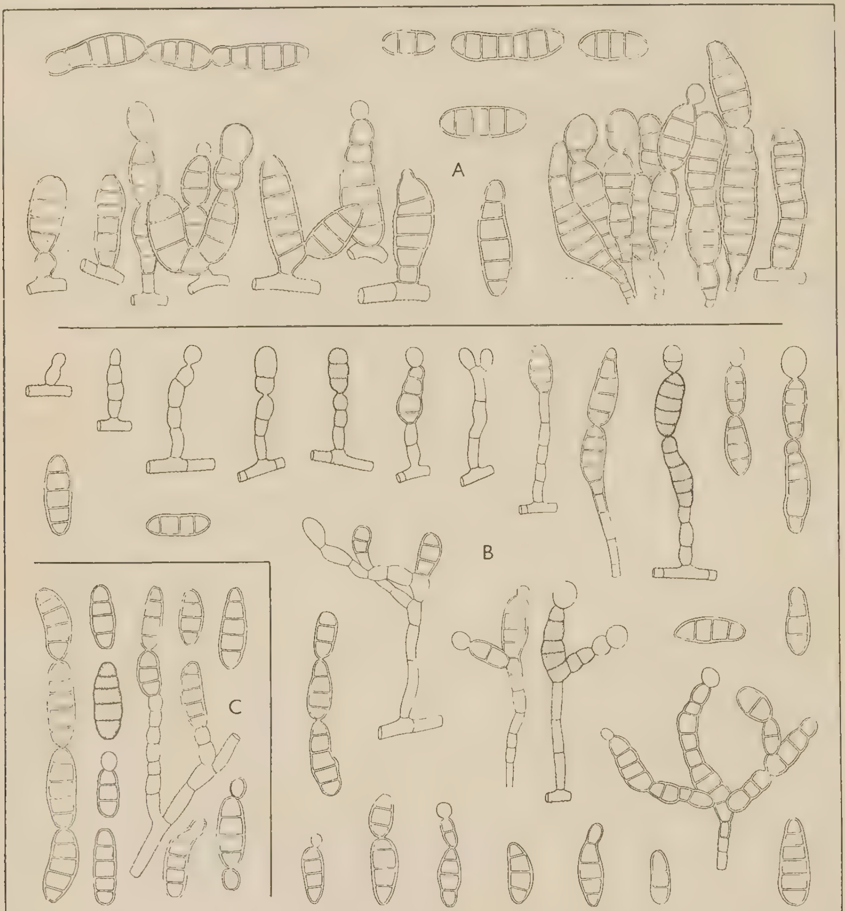


Fig. 3. *Mytilidion karstenii* (conidial): A, conidiophores and conidia from Herb. I.M.I. 27743, the conidiophores on the left arising from surface hyphae and those on the right from immersed hyphae emerging from a medullary ray; B, conidiophores and conidia from a 16-day-old culture, started from conidia, on potato-dextrose agar; C, conidiophores and conidia from a 6-month-old culture, started from ascospores, on malt agar, of Herb. I.M.I. 23123; all × 500.

Cultures were made from the conidia of 27743 (Fig. 3B). On potato-dextrose agar, 16-day-old colonies are very dark brown to almost black and up to 15 mm. wide. The aerial mycelium is composed of pale brown to brown, septate, branched, rough-walled hyphae which are 2–4μ wide. The conidiophores are for the most part developed as upright lateral branches of the aerial or partially immersed hyphae. In culture, as on the host, they are irregular but generally take the form of a hypha of variable length, constricted at the septa, and which expands and becomes thick-walled and dark brown towards the apex on which an acropetal chain of conidia develops; the conidiophores, which are generally smooth, may be sometimes much branched whilst the conidial chains may also be forked. The conidia are generally smooth but otherwise resemble very closely those produced on the host, and agree with those previously obtained in cultures from ascospores (Fig. 3C).

More collections of British Hysteriales are needed; for example, *Lophium elatum* and *Glonium amplum* should be re-collected, and a first collection made of the hysterothecia (?and conidia) of *Hysterium insidens*. There are doubtless interesting collections to be made in many areas, perhaps particularly in northern Scotland. Anyone who can find a young development of any species and remove a hysterothecium about once a month and examine it should be able to tell us whether the species is annual, biennial, or perennial.

KEY TO THE BRITISH HYSTERIALES

The key to the known British Hysteriales can now be revised to include the data given in this paper and the two preceding. It may be noted that the species with erect mussel-shaped hysterothecia are on conifers, the one with dolabrate hysterothecia is on branches especially of Rosaceae, the others are on branches of various dicotyledonous trees and shrubs except *Hysterium acuminatum*, which is found on conifers. The abbreviation Hyst. = hysteriothecia, spores = ascospores.

Hyst. erect conchate or dolabrate:	
With pale greenish scolecospores	**Lophium**
Hyst. conchate, spores 100–180 × 1·5–2·5μ	L. mytilinum
Hyst. dolabrate, spores 150–330 × 2–3μ	L. elatum
With brownish phragmospores	**Mytilidion**
Spores 16–22 × 2·5–3μ, 1–3 septate	M. laeviusculum
Spores 28–42 × 3·5–4μ, 3–4 septate	M. karstenii
Spores 30–40 × 5–7μ, 7–9 septate	M. gemmigenum
Hyst. navicular to elongate:	
With brown, papillate amerospores	**Farlowiella**
One species; spores 18–27 × 7–12μ	F. carmichaeliana
With hyaline didymospores	**Glonium**
Spores 12–14 × 5–7μ	G. lineare
Spores 18–22 × 5–6μ, becoming brown	?G. amplum
With brown phragmospores	**Hysterium**
3-septate, 12–18 × 5–6μ, on conifers	H. acuminatum
3-septate, 15–24 × 5–7μ, on hardwoods	H. angustatum
3-septate, 18–35 × 6–10μ, end cells paler	H. pulicare
4–9-septate, 21–38 × 6–12μ	H. insidens

With hyaline dictyospores	**Gloniopsis**
Spores 15–30 × 6–10μ	G. levantica
With brown dictyospores	**Hysterographium**
Spores 15–30 × 7–10μ	H. mori
Hyst. erumpent; spores 30–50 × 12–20μ	H. fraxini
Hyst. on bare wood; spores similar, ?darker	H. elongatum

REFERENCES

Bisby, G. R. (1932). Type specimens of certain Hysteriales. *Mycologia*, **24**, 304–329.

Bisby, G. R. (1941). British species of *Hysterium*, *Gloniopsis*, *Dichaena* and *Mytilidion*. *Trans. Brit. mycol. Soc.* **25**, 127–140.

Bisby, G. R. (1944). The British Hysteriales. II. *Trans. Brit. mycol. Soc.* **27**, 20–28.

Bucknall, C. (1886). The fungi of the Bristol district. Part. IX. *Proc. Bristol Nat. Soc.* **5**, 50.

Duby, J. E. (1862). Mémoire sur la tribu des Hystérinées. *Mém. Soc. Phys. Genève*, **16**, 15–70.

Ellis, J. B. & Everhart, B. M. (1892). *The North American Pyrenomycetes*, p. 696.

Hughes, S. J. (1951). *Septonema secedens* Corda. *Naturalist, Lond.*, 1951, 173–176.

Hughes, S. J. (1952). *Sirodesmium granulosum* and *Torula diversa*. *Naturalist, Lond., 1952*. 93–98.

Lohman, M. L. (1939). Karsten's type specimens of Hysteriaceae on conifers. *Mycologia*, **31**, 354–365.

Mason, E. W. (1941). *Annotated account of fungi received at the Imperial Mycological Institute*, List II, Fasc. 3, Special Part.

Rehm, H. (1887). *Rabenh. Krypt.-Flora*, 2 Aufl., **1**, Abt. 3, p. 15.

Teng, S. C. (1933). Notes on Hysteriales from China. *Sinensia*, **4**, 129–144.

Watson, W. (1948). List of British fungi parasitic on lichens.... *Trans. Brit. mycol. Soc.* **31**, p. 330.

Zogg, H. (1943). Untersuchungen über die Gattung *Hysterographium*. *Phytopath. Z.* **14**, 310–384.

Zogg, H. (1949). Beitrag zur Kenntnis der brasilianischen Hysteriaceen. *Ber. schweiz. bot. Ges.* **59**, 23–44.

(*Accepted for publication* 14 *February* 1952)

INDEX

New names are indicated by an asterisk

Absidia glauca, 266
Acaulopage tetraceros, 158–159
Acia stenodon, 39–40
Acrostalagmus albus, 218
Actinospora megalospora n.sp., an aquatic hyphomycete, by C. T. Ingold, 66–70
*Actinospora megalospora n.gen., n.sp., 66–70
Agarics, size and form in, 190–194
Ainsworth, G. C. 'Review: Les Uredinées, Tome 2, by A. L. Guyot; and Uredineana, Tome 3, Ed. A. L. Guyot', 93
Ainsworth, G. C. 'Review: Review of Medical and Veterinary Mycology', 240
Ainsworth, G. C.; 'The Lister Notebooks', 188–189
Alatospora acuminata, 158
Aleurodiscus apricans, 37, 44
  aurantius, 37, 44
  *delicatus, 37, 45
  oakesii, 37, 45
Alternaria tenuis, 125, 218
  sp., 125
Anguillospora longissima, 158
Annual General Meeting 1951, 163
Antidesma rust, 26–28
Apple, Armillaria mellea on, 201–207
Aquatic ascomycetes: *Loramyces juncicola* Weston, and *L. macrospora* n.sp., by C. T. Ingold and B. Chapman, 268–272
Aquatic predacious fungi. II, by Mary Peach, 19–23
Arbutus unedo, 36
Armeria sp., 81–90
Armillaria mellea, 201–207
Arx, J. A. von and Olivier, Dorothea L.: 'The taxonomy of *Ophiobolus graminis* Sacc.', 29–33
Aspergillus brevipes n.sp., by George Smith, 241–242
*Aspergillus brevipes, 241–242
  fumigatus, 218
  humicola, 263–267
  niger, 266
  terreus, 218, 266
Asterostroma laxum, 40–41
  medium, 41–42
Avena spp., *Erysiphe graminis* on, 71–80

Bacillus coli, 266
  subtilis, 266
Bacterium globiforme, 266
Bakshi, B. K.: '*Oedocephalum lineatum* is a conidial stage of *Fomes annosus*', 195
Balfour-Browne, Frances L.: 'Three moulds from damp walls', 273–278
Batts, C. C. V., *see* Dovaston, H. F.
Bisby, G. R.: 'Fifty-year Index to the *Transactions*' (Notice), 161
Bisby, G. R.: 'The name *Oidium*', 236–237
Bisby, G. R. and Dennis, R. W. G.: 'Notes on British Hysteriales', 304–307
Bisby, G. R. and Ellis, M. B.: '*Lophium elatum* Grev.', 299–303
Bisby, G. R. and Hughes, S. J.: 'Summary of the British Hysteriales', 308–314
Blackcurrant, *Armillaria mellea* on, 201–207
Boletus pruinatus, 122
Bond, T. E. T.: 'A further note on size and form in agarics', 190–194
Bond, T. E. T.: '*Septoria armeriae* Allesch., the cause of a leaf-spot disease of "Bees Ruby" *Armeria*', 81–90
Botrytis allii, 264–266
  cinerea, 257
  sp., 256
Brachysporium bloxami, 125
Brown core root rot of *Primula* caused by *Phytophthora primulae* n.sp., by J. A. Tomlinson, 221–235

Capnodium footii and *Strigula babingtonii*, by R. W. G. Dennis and M. B. Ellis, 196–200
Carex spp., rusts on, 130
Cephalosporium acremonium, 218
Ceratobasidium anceps, 63
  atratum, 59, 64
  terrigenum, 59, 64–65
Ceratosporella bicornis, 246
  *stipitata, 243–247
Ceuthocarpon, 30–31
  populinum, 30–31
Chaetomium globosum, 218–219, 257
*Chaetothyrium babingtonii, 196–200
Chapman, B., *see* Ingold, C. T.
Cheesman and Pethybridge Bequests (Notice), 96
Cladaria, 290
Cladium mariscus, 45, 63
Clasterosporium claviforme var. leptopus, 156
  opacum, 154
Clavaria, 285–298
Clavariaceae, generic names in, 285–298
Clitocybe orbiformis, 100
  osmophora, 100
*Collybia ferruginella, 102–103
  *griseospora, 102
  *paupertina, 103
Composts, fungi of, 215–220
Coniophora betulae, 43
  lividum, 125
  mustialiensis, 41, 43
  spp., 124
Coniothyrium sp., 253
Coolia odorata, 99
Coprinus lagopus, 218–219

Corner, E. J. H.: 'Generic names in Clavariaceae', 285–298
Corticium amianthinum, 41, 46
  anceps, 63
  anomalum, 37, 53
  argillacea, 56
  asseriphilum, 37, 51
  atrovirens var. spora majore, 47
  bysinellum, 41, 46
  coroniferum, 39
  filium, 41, 47
  fuscoatratum, 41, 48
  geogenium, 37, 53
  granulosum, 37, 54
  illaqueatum, 47
  lacteum, 49
  laetum, 48
  lentum, 37, 54
  leucoxanthum, 41, 54
  ochraceo-fulvum, 41, 50
  ochroleucum, 48, 54
  pallidum, 37, 55
  pulchrum, 41, 47
  pulverulentum, 37, 51
  reconditum, 37, 52
  rickii, 41, 49
  subseriale, 41, 50
  terrigenum, 64
  tessulatum, 41, 47
  tuberculatum, 49
Cortinarius acutus, 116
  adalbertii, 116
  biformis, 116
  citrinus, 114
  depressus, 117
  elegantior, 114
  hoeftii, 117
  malicorius, 115
  sodagnites, 115
  sulfureus, 114
  sulfurinus var. langei, 114
  subturbinatus, 114
Crepidotus wakefieldii, 113–114
Cryptocoryneum hysterioides, 125
Cryptoderis lamprotheca, 30
Curtis, P. J., Hemming, H. G. and Jeffreys, E. G.: 'Humicolin, an antifungal substance produced by *Aspergillus humicola*', 263–267
Cylindrocarpon radicicola, 249–250, 255, 257
Cyphella albocarnea, 62
  citrispora, 62
*Cystopsora antidesmatis, 26–28

*Dactylaria scaphoides, 19–22
Dactylella doedycoides, 146
  heptameres, 22–23
  *mammillata, 144–145
Dactylis glomerata, 208
Dennis, R. W. G. 'Review: Puffballs and their allies in Michigan, by A. H. Smith', 95
Dennis, R. W. G., *see* Bisby, G. R.
Dennis, R. W. G. and Ellis, M. B.: '*Capnodium footii* and *Strigula babingtonii*', 196–200
Dichaena, 306
Dicoccum uniseptatum, 125
Dispersal of fungus spores by small animals inhabiting wood and bark, by P. H. B. Talbot, 123–128
Dixon, Sylvia M.: 'Predacious fungi from rotten wood', 144–148
Donkella, 291
Dovaston, H. F. and Batts, C. C. V.: 'A study of rusts found on *Pedicularis*', 129–143
Dowson, W. J. 'Review: Manual of Bacterial Plant Pathogens, by Charlotte Elliott', 238–239
Drosophila pygmea, 120

Eastwood, D. Jean: 'The fungus flora of composts', 215–220
Effect of partial sterilization by steam or formalin on damping-off of Sitka spruce, by J. H. Warcup, 248–262
Elaphomyces aculeatus, 282, 284
  rubescens, 284
Eleocharis palustris, 268, 270
Ellis, E. A., *see* Ingold, C. T.
Ellis, M. B., *see* Bisby, G. R.
Ellis, M. B., *see* Dennis, R. W. G.
Entoloma aprile, 111
  erophilum, 110–111
Epicoccum sp., 125
Equisetum limosum, 268, 270
Erysiphe graminis, 71–80

Farlowiella carmichaeliana, 308, 313
Field observations on the spread of *Armillaria mellea* in apple orchards and in a blackcurrant plantation, by R. W. Marsh, 201–207
Fifty-year Index to the *Transactions*, by G. R. Bisby (Notice), 161
Fomes annosus, 195
Forays, 1951: Hereford, 168
  London and provincial, 176
  Marlborough, 165
Fraymouth, Joan and Hawker, Lilian E.: 'The use of commercial "Pectozyme" in the anatomical study of parasitic fungi within plant tissues', 91
Fumago fagi, 196–200
Fungus flora of composts, by D. Jean Eastwood, 215–220
Further note on size and form in agarics, by T. E. T. Bond, 190–194
Fusarium coeruleum, 266
  culmorum, 250, 257
  equiseti, 250, 257
  oxysporum, 250, 257
  sambucinum, 250
  sp., 125

*Gaeumannomyces, 32
*Gaeumannomyces graminis, 32
Galera sphagnorum, 113
  tibiicystis, 113
Galerina tibiicystis, 113
Galium aparine, 62
Gautieria morchellaeformis, 282–283
Generic names in Clavariaceae, by E. J. H. Corner, 285–298
Gliocladium penicilloides, 218

Gloeocystidium analogum, 53
argillaceum, 55
furfuraceum, 54
inaequale, 53
ochroleucum, 54
Gloniopsis levantica, 308–309, 314
Glonium amplum, 313
lineare, 313
Graminicolous pyrenomycetes. IV. *Microthyrium nigro-annulatum* n.sp. and *M. gramineum*, by J. Webster, 208–214
G. R. B. 'Review: The fungi of Hertfordshire, by P. H. Gregory', 240
Gregory, P. H., Presidential Address: 'Fungus spores', 1–18
Griffiths, D. J., *see* Jones, E. T.

Harposporium helicoides, 147–148
*lilliputanum, 146–147
Hawker, Lilian E.: 'Hypogeous fungi. II and III', 279–284
Hawker, Lilian E.: 'The Lister Memorial Lecture: The Physiology of Myxomycetes', 177–187
Hawker, Lilian, R., *see* Fraymouth, Joan
Hebeloma pusillum, 112
Helminthosporium apiculatum, 125
longipilum, 125
nanum, 243
Hemming, H. G., *see* Curtis, P. J.
Heterographa, 306
Hippophaë rhamnoides, 36, 38
Hora, F. B. 'Review: Champignons comestibles, by G. Herter', 94–95
Hughes, S. J.: '*Speira stipitata*', 243–247
Hughes, S. J.: '*Trichocladium* Harz', 152–157
Hughes, S. J., *see* Bisby, G. R.
Humicolin, an antifungal substance produced by *Aspergillus humicola*, by P. J. Curtis, H. G. Hemming and E. G. Jeffreys, 263–267
Hydnangium carneum, 279–281
*carneum var. xanthosporum, 281
Hydrocybe pateriformis, 116
Hygrocybe constans, 105
langei, 105
obrussea, 105
rickenii, 105
*Hygrophorus langei, 105–106
Hymenogaster hessei, 282–284
Hypochnus furfuraceus, 54
Hypogeous fungi, II and III, by Lilian E. Hawker, 279–284
Hysteriales, 299–314
Hysterium acuminatum, 313
angustatum, 309, 313
insidens, 309, 313
pulicare, 313
Hysterographium elongatum, 305–306, 314
fraxini, 305, 309–310
mori, 310, 314
rousselii, 310

Ingold, C. T.: '*Actinospora megalospora*, n.sp., an aquatic hyphomycete', 66–70
Ingold, C. T. 'Review: Researches on Fungi, Vol. VII, by A. H. R. Buller', 92–93
Ingold, C. T. and Chapman, B.: 'Aquatic ascomycetes: *Loramyces juncicola* Weston and *L. macrospora* n.sp.', 268–272
Ingold, C. T. and Ellis, E. A.: 'On some hyphomycete spores, including those of *Tetracladium maxilliformis*, from Wheatfen', 158–161
Inocybe grammata, 119
pudica, 118
rubescens, 118
xanthomelas, 118

Jeffreys, E. G., *see* Curtis, P. J.
Jones, E. T. and Griffiths, D. J.: 'Varietal resistance and susceptibility of oats to powdery mildew (*Erysiphe graminis*), 71–80
Juncus articulatus, 268

Kneiffia polonensis, 61
Korf, Richard P.: 'Two techniques for showing spore markings in operculate discomycetes', 24–25

Lachnocladium, 292
Lactarius decipiens, 108
mairei var. zonatus, 107–108
Lepiota albo-serica, 98
odorata, 99
*pinguipes, 97–98
serena, 98
sub-alba, 98
Leptoporus braunii, 35
kymatodes, 34–35
rufoflavus, 35
Lindtneria trachyspora, 37–38
Linospora, 30–31
Linospora capreae, 30–31
Lister, Arthur (Portrait), 177
Lister Memorial Lecture: The Physiology of Myxomycetes, by Lilian E. Hawker, 177–187
Lister Notebooks, by G. C. Ainsworth, 188–189
Lonicera periclymenum, 300
Lophium dolabriforme, 300–302
elatum, 299–303, 313
mytilinum, 306–313
Lophium elatum Grev., by G. R. Bisby and M. B. Ellis, 299–303
Loramyces juncicola, 268–272
*macrospora, 268–272

Marasmius capillaris, 104
cauvetii, 104
epiphylloides, 105
eufoliatus, 103–104
littoralis, 104–105
recubans, 103
Marsh, R. W.: 'Field observations on the spread of *Armillaria mellea* in apple orchards and in a blackcurrant plantation', 201–207
Masonia, a new genus of hyphomycetes, by George Smith, 149–151
*Masonia, 149
*Masonia chartarum, 150–151, 237
*grisea, 149–151, 237

Masoniella nom. nov., by G. Smith, 237
*Masoniella, 237
*Masoniella chartarum, 237
  *grisea, 237
Meetings 1951, 162
Merulius lacrymans, 125–127
  spp., 124
Microthyrium gramineum, 208–214
  gramineum var. major, 208–214
  *nigro-annulatum, 208–210
  psamminum, 213–214
Microxyphium footii, 196–200
Mollisia arenevaga, 213
Monilia candicans, 125
Monotospora carmichaeliana, 308
  sphaerocephala, 125
  sp., 218
Mortierella sp., 253, 257
Moore, W. C. 'Review: Flora of the British Isles, by A. R. Clapham, T. G. Tutin and E. F. Warburg', 239–240
Mucor abundans, 218
  mucedo, 266
  spinescens, 218
  varians, 218
Mycena clavularis, 101
  osmundicola, 100
  pseudo-pura, 101–102
  salicina, 101
Myrothecium verrucaria, 266
Mytilidion gemmigenum, 310–311, 313
  karstenii, 311, 313
  laeviusculum, 304–305, 313
Myxomycetes, Physiology of, 177–187

Naucoria jennyae, 112
New or rare British Hymenomycetes (Aphyllophorales), by Elsie M. Wakefield, 34–65
New records and observations, V, by A. A. Pearson, 97–122
New rust on *Antidesma* in India, by T. S. Ramakrishnan and N. V. Sundaram, 26–28
Notes on British Hysteriales, by G. R. Bisby and R. W. G. Dennis, 304–307

Oat mildew, 71–80
Odontia corrugata, 40
  junquillea, 40
Oedocephalum lineatum is a conidial stage of *Fomes annosus*, by B. K. Bakshi, 195
Oidium, The name, by G. R. Bisby, 236–237
Oidium, 236–237
Oidium candicans, 63
Oligonema nitens, 125
*Omphalia roseotincta, 105
Oospora variabilis, 218
Ophiobolus acuminatus, 29
  graminis, 29–33
  moravicus, 31
Ophiognomonia, 31
Ophiognomonia melanostyla, 31

Peach, Mary: 'Aquatic predacious fungi. II', 19–23
Pearson, A. A.: 'New records and observations. V', 97–122
Pearson, A. A. 'Review: Agaricalium Europaeorum clavis dichotoma, by A. Pilát', 238
Pearson, A. A. 'Review: The "Agaricales" (Mushrooms) in modern taxonomy, by R. Singer', 96
Pedicularis spp., rusts on, 129–143
Pellicularia pruinata, 41, 63
  subcoronata, 125–127
  sp., 125
Penicillium expansum, 266
  gladioli, 266
  jenseni, 257
  luteum, 255
  nigricans, 255
  purpurogenum, 255
  wortmanni, 255
Peniophora affinis, 56, 59
  albostraminea, 56
  argillacea, 56, 59
  canadensis, 61
  carneola, 56
  chordalis, 58–59
  crassa, 58
  filamentosa, 59–60
  mollis, 59, 61
  polonensis, 59, 61
  proxima, 59, 62
  pulverulenta, 51
  *reticulata, 57, 59
Phaeocollybia jennyae, 112
Phellinus robustus f. hippophaës, 36
  torulosus, 35–36
P. H. G. 'Review: The intelligent use of the microscope, by C. W. Olliver', 239
Pholiota pumila var. subferruginea, 111
Phoma eupyrena, 253, 256–257
Physiology of Myxomycetes, 177–187
Phytophthora erythroseptica, 257
  fragariae, 224
  *primulae, 221–235
Picea sitchensis, 248–262
Pinus sylvestris, 106
Plagiosphaera, 31
Plagiosphaera moravica, 31
Plant Pathology Field Day 1950, 176
Pleuroceras, 30
Pleuroceras cryptoderis, 30
  melanostyla, 31
Pleurotus tessulatus, 125–126
Pluteus caloceps, 109
  coccineus, 109
  leoninus var. coccineus, 109
  *lepiotoides, 109–110
  plautus, 108–109
  *splendidus, 110
Polyporus kymatodes, 34
  metamorphosus, 38
  radiatus, 125
  torulosus, 35
Polystictus versicolor, 125
Poria metamorphosa, 38
  onusta, 39
  trachyspora, 38
Predacious fungi from rotten wood, by Sylvia M. Dixon, 144–148

- Presidential Address: 'Fungus spores', by P. H. Gregory, 1–18
- *Primula* brown core, 221–235
- Proceedings 1951, 162–176
- Psalliota bernardii, 122
  - bitorquis, 121
  - haemorrhoidaria, 121–122
  - langei, 121
  - rodmanii, 121
- Psathyra fatua, 119–120
  - fusca, 120
- Psathyrella fatua, 119
  - fusca, 120
  - impatiens, 119
  - pygmea, 120
- Pteridium aquilinum, 63
- Pterula, 295
- Puccinia clintonii, 129–143
  - lapponica, 129–143
  - lapponica subsp. jenissejensis, 129–143
  - paludosa, 129–143
  - pedicularis, 129–143
  - poarum, 125
- Pythium acanthicum, 250, 252, 257, 259–260
  - aphanidermatum, 222, 232
  - dissotocum, 250, 257, 260
  - intermedium, 250, 252, 257, 259–260
  - mamillatum, 260
  - rostratum, 250, 257, 260
  - ultimum, 250, 252, 254–255, 257–260

- Ramakrishnan, T. S. and Sundaram, N. V.: 'A new rust on *Antidesma* in India', 26–28
- Ramaria, 285
- Receipts and Payments 1951, 164
- Review: Agaricalium Europaeorum clavis dichotoma, by A. Pilát (by A. A. Pearson), 238
  - Champignons comestibles, by G. Herter (by F. B. Hora), 94–95
  - Flora of the British Isles, by A. R. Clapham, T. G. Tutin and E. F. Warburg (by W. C. Moore), 239–240
  - Les Uredinées, Tome 2, by A. L. Guyot (by G. C. Ainsworth), 238–239
  - Manual of bacterial plant pathogens, 2nd ed., by Charlotte Elliott (by W. J. Dowson), 238–239
  - Puffballs and their allies in Michigan, by A. H. Smith (by R. W. G. Dennis), 95
  - Researches on Fungi, Vol. VII, by A. H. R. Buller (by C. T. Ingold), 92–93
  - Review of Medical and Veterinary Mycology (by G. C. Ainsworth), 240
  - The 'Agaricales' (Mushrooms) in modern taxonomy by Rolf Singer (by A. A. Pearson), 96
  - The fungi of Hertfordshire, by P. H. Gregory (by G. R. B.), 240
  - The intelligent use of the microscope, by C. W. Olliver (by P. H. G.), 239
  - Uredineana, Tome 3, ed. A. L. Guyot (by G. C. Ainsworth), 93
- *Rhinotrichum domesticum, 273–275
  - lanosum, 274–275
- Russula cessans, 106

- Scirpus lacustris, 268
- *Sepedonium albo-griseum, 276–277
- *Septoria armeriae* Allesch., the cause of a leaf-spot disease of 'Bees Ruby' *Armeria*, by T. E. T. Bond, 81–90
- Septoria armeriae, 81–90
- Sistotrema ericetorum, 39
  - sulphureum var. retigera, 38
- Sitka spruce, 248–262
- Smith, G.: '*Aspergillus brevipes*, n.sp.,', 241–242
- Smith, G.: '*Masonia*, a new genus of hyphomycetes', 149–151
- Smith, G.: '*Masoniella*, nom. nov.', 237
- Some hyphomycete spores, including those of *Tetracladium maxilliformis*, from Wheatfen, by C. T. Ingold and E. A. Ellis, 158–161
- *Speira stipitata*, by S. J. Hughes, 243–247
- Speira stipitata, 234–247
  - toruloides, 125
- Sporidesmium abruptum, 125
  - opacum, 156
  - sp., 125
- Sporochisma mirabile, 125
- Staphylococcus aureus, 266
- Stemphylium botryosum, 125
  - sp., 266
- Stereum karstenii, 58
- Strigula babingtonii, 196–200
- Study of rusts found on *Pedicularis*, by H. F. Dovaston and C. C. V. Batts, 129–143
- Stylopage lepta, 20–23
- Summary of the British Hysteriales, by G. R. Bisby and S. J. Hughes, 308–314
- Sundaram, N. V., *see* Ramakrishnan, T. S.

- Talbot, P. H. B., 'Dispersal of fungus spores by small animals inhabiting wood and bark', 123–128
- Taxonomy of *Ophiobolus graminis* Sacc., by J. A. von Arx and Dorothea L. Olivier, 29–33
- Tetracladium angulatum, 158
  - marchalianum, 158–159
  - maxilliformis, 159–160
  - setigerum, 158–160
  - splendens, 158
- Thamnidium elegans, 266
- Thelephora aurantia, 44
- Three moulds from damp walls, by Frances L. Balfour-Browne, 273–278
- Titaea ornithomorpha, 158–159
- Tomlinson, J. A.: 'Brown core root rot of *Primula* caused by *Phytophthora primulae* n.sp.', 221–235
- Torula herbarum, 125
- Trechispora coronifera, 39
  - onusta, 39
- *Trichocladium* Harz, by S. J. Hughes, 152–157
- Trichocladium asperum, 152–154
  - olivaceum, 153
  - *opacum, 154–157
  - spp., 152–157
- Trichoderma viride, 218, 253, 255–257, 266
- Tricholoma odoratum, 99
  - persicinum, 99
- Trichothecium roseum, 125
- Tubaria embola, 113

Two techniques for showing spore markings in operculate discomycetes, by Richard P. Korf, 24–25

Use of commercial 'Pectozyme' in the anatomical study of parasitic fungi within plant tissues, by Joan Fraymouth and Lilian E. Hawker, 91

Varietal resistance and susceptibility of oats to powdery mildew (*Erysiphe graminis*), by E. T. Jones and D. J. Griffiths, 71–80

Wakefield, Elsie M.: 'New or rare British Hymenomycetes (Aphyllophorales)', 8, 34–65

Warcup, J. H.: 'Effect of partial sterilization by steam or formalin on damping-off of Sitka spruce', 248–262

Webster, J.: 'Graminicolous pyrenomycetes. IV. *Microthyrium nigro-annulatum* and *M. gramineum*', 208–214

Zygorrhynchus moelleri, 218

THE BRITISH MYCOLOGICAL SOCIETY
TRANSACTIONS

Vol.	PART 1	2	3	4	5
1	*m*	*m*	6*s.*	*m*	*m*
2	[		68*s.*		]
3	[		80*s.*		]
4	[16*s.*]	*m*	—	—	—
5	*m*	*m*	*m*	—	—
6	*m*	*m*	(20*s.*)		—
7	(		40*s.*	)	—
8	(		40*s.*	)	—
9	(	20*s.*)	*m*	*m*	—
10	(		40*s.*	)	—
11	(		40*s.*	)	—
12	[		40*s.*	]	—
13	[		40*s.*	]	—
14	(		40*s.*	)	—
15	*m*	*m*	(20*s.*	)	—
16	*m*	[	30*s.*	]	
17	*m*	*m*	(10*s.*)	*m*	—
18	*m*	[	30*s.*	]	—
19	*m*	(	30*s.*	)	—
20	(		40*s.*	)	—

Vol.	PART 1	2	3	4
21	(	40*s.*		)
22	(	40*s.*		)
23	(	40*s.*		)
24	(	40*s.*		)
25	(	40*s.*		)
26	(	40*s.*		)
27	(	40*s.*		)
28	(	40*s.*		)
29	(	40*s.*		)
30	(	Jubilee Vol. 20*s.*		)
31	(	50*s.*		)
32	[	25*s.*]	*m*	*m*
33	(	50*s.*		)
34	(	50*s.*		)

m = out of print, available on microfilm to order

( ) = volume (or part volume) sold separately

[ ] = only sold as part of a long set of volumes

REPRINTS AND MISCELLANEOUS PUBLICATIONS

PLANT PATHOLOGY COMMITTEE: *List of Common British Plant Diseases*, 3rd Ed. 1945. Price net, 5*s.* Postage, 4*d.*

A. A. PEARSON: *Cooke's illustrations of British Fungi* (*Annotations by L. Quélet, R. Maire & C. Rea*). *Ex* Vol. 20, Pt. 1. 1935. Price net, 2*s.* 6*d.* Postage, 3*d.*

T. PETCH: *British Hypocreales. Ex* Vol. 21, Pts. 3 & 4. 1938. Price net, 2*s.* Postage, 3*d.*

A. A. PEARSON & R. W. G. DENNIS: *Revised list of British Agarics and Boleti. Ex* Vol. 31, Pts. 3 & 4. 1948. Price net, 5*s.* Postage, 3*d.*

J. RAMSBOTTOM & F. L. BALFOUR-BROWNE: *List of Discomycetes recorded from the British Isles. Ex* Vol. 34, Pt. 1. 1951. Price net, 5*s.* Postage, 3*d.*

FIFTY YEAR INDEX TO THE TRANSACTIONS, Vols. 1–30; 1896–1946. Compiled by G. R. BISBY. Price net, 21*s.* Postage, 6*d.*

Enquiries and orders for the above to be addressed to

CAMBRIDGE UNIVERSITY PRESS,
200 EUSTON ROAD, LONDON, N.W. 1
or to
CAMBRIDGE UNIVERSITY PRESS
AMERICAN BRANCH, 32 EAST 57TH STREET, NEW YORK 22

FORAY COMMITTEE PUBLICATIONS

(*To be obtained from the Treasurer and on sale at meetings and forays*)

A key to the genera of the agarics and Boleti. By A. A. PEARSON. 32 pp. 1950. Price net, 2*s.* 6*d.* Postage, 2*d.*

Guide to the literature for the identification of British fungi. 1952. Price net, 2*s.* 6*d.* Postage, 2*d.*

CONTENTS

PAGE

Aspergillus brevipes n.sp. By George Smith. (With Plate 10) 241

Speira stipitata. By S. J. Hughes. (With 4 Text-figures) 243

Effect of partial sterilization by steam or formalin on damping-off of Sitka spruce. By J. H. Warcup. (With Plate 11 and 1 Text-figure) 248

Humicolin, an antifungal substance produced by *Aspergillus humicola*. By P. J. Curtis, H. G. Hemming and E. G. Jefferys 263

Aquatic Ascomycetes: *Loramyces juncicola* Weston and *L. macrospora* n.sp. By C. T. Ingold and B. Chapman. (With Plate 12 and 3 Text-figures) 268

Three moulds from damp walls. By Frances L. Balfour-Browne. (With 2 Text-figures) 273

Hypogeous fungi. II and III. By Lilian E. Hawker. (With 2 Text-figures) . . . 279

Generic names in Clavariaceae. By E. J. H. Corner 285

Lophium elatum Grev. By G. R. Bisby and M. B. Ellis. (With 1 Text-figure) . . 299

Notes on British Hysteriales. By G. R. Bisby and R. W. G. Dennis. (With 1 Text-figure) 304

Summary of the British Hysteriales. By G. Bisby and S. J. Hughes. (With 3 Text-figures) 308

Index 315

INSTRUCTIONS TO AUTHORS

Contributors are asked to be clear and concise, and to use a recent issue of the *Transactions* as a guide to the arrangement of headings and subheadings, explanations of plates and figures, references to the literature, and other details. Each paper should start with a short summary.

The standards adopted in the *Transactions* are those outlined in the Royal Society's pamphlet, *General Notes on the Preparation of Scientific Papers* (1950, Cambridge University Press, 200 Euston Road, London N.W. 1, price 2*s*. 6*d*.). An exception is that in the *Transactions* citations of references to literature, although based on the Harvard system, include the full titles of the papers and complete page numbers. Titles of journals are abbreviated in accordance with *A World List of Scientific Periodicals*, 1952.

The scientific names of genera and species are printed in italics and should be underlined in the typescript. The title of the paper, headings, and subheadings may be in capitals, but should not be underlined.

The attention of authors proposing new taxonomic groups is drawn to the need to give an adequate description and figure, and to designate the types as required by the *International Rules of Botanical Nomenclature*. The description of a new species should be accompanied by a figure, and whenever possible the type specimen should be deposited in one of the national herbaria.

The British Mycological Society subscribes to the Fair Copying Declaration, details of which may be obtained from the offices of the Royal Society.

Printed in Great Britain at the University Press, Cambridge (Brooke Crutchley, University Printer)